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ATMOSPHERIC ELECTRICITY[1]

THE industrial application of electricity for light and for power began about thirty years ago. There were then no schools or laboratories in which applied electricity was taught. The science or profession of electrical engineering did not exist. Electricity was taught as a part of the physics course in schools or colleges and, incidentally thereto, brief descriptions of its application to telegraphy were included. Electroplating, the electric arc and electromagnetism were studied chiefly from books and sometimes illustrated with such instruments and apparatus as were to be found in the apparatus collection.

When, however, the great growth or expansion began, about thirty years ago, courses in electrical engineering were gradually added in some of the schools, usually in conjunction with the teaching of physics, to which the new study was most closely allied. The physics department of Princeton under Professor Brackett was among the very earliest to provide instruction in what was in fact the incipient stage of the now highly developed and important science of applied electricity. Those in the field whose memories carry them back to that early time, will easily recall the important contributions made by Professor Brackett and his department to the development of the infant science. On this present occasion Princeton is to be congratulated on the opening of its magnificent new laboratory, the generous gift of Mr. Palmer, which assures the possibil-

[1] Address at the formal opening of the Palmer Physical Laboratory at Princeton University, October 21, 1909.

ity of continued growth and usefulness, in larger measure, in those sciences to the study of which it is devoted.

As a part of the commemorative exercises at this formal opening of the Palmer laboratories, I have been requested to address you upon some topic connected with physics and electrical engineering. Out of a number of subjects which suggested themselves I have chosen "atmospheric electricity"—a subject which permits of a treatment not too technical and which more or less concerns us all. Its relation to the science of physics is evident, and as to electrical engineering, we electrical engineers are sometimes made to experience a wish that it were not so closely related, for, under certain conditions it is perhaps the one thing which menaces in a high degree the integrity of the delicate contrivances which make up an electric installation; interfering most unexpectedly with continuity of service.

I hope that in what I shall say on the subject my physicist friends will bear with me, for I realize that there is little of novelty that I can present. I can but emphasize what I believe to be correct views and treat the matters discussed very generally, if not popularly. While my attitude towards the subject itself has always been that of a learner, it has often fallen to my lot to exert myself to provide means for the protection of electrical installations from such damage by lightning storms as would involve great inconvenience and perhaps heavy monetary loss. The engineer must produce things that do the work and often the need is immediate and compelling. The student of pure science is under no such stress.

From the remotest times the thunderstorm has been one of the most impressive of natural phenomena, inspiring terror in men and other creatures alike. The realization of its interest and grandeur is probably of comparatively modern origin. It is indeed not surprising that in pagan mythology the lightning stroke was ascribed to the anger of the greatest of the gods. It is no wonder that, in one of the greatest poems of the Bible, Job is asked, "Canst thou send lightnings that they may go and say unto thee, 'Here we are'?"

With the decay of authority and miraculous interpretation of natural phenomena and the gradual growth of rationalism and scientific study the recognition of the lightning and the thunder as a result of natural processes gradually came about. In the seventeenth century began that gradual awakening to the possibilities of the conquest of nature, the outcome of which is modern science with all its great achievements. It was the period of Bacon, Galileo, Gilbert, Descartes, Newton and others. At first the explosive action of lightning, the noise of the thunder and the subsequent strong smell of ozone, which often exists, suggested a kinship with gunpowder, or, that certain nitrous and sulphurous constituents of the atmosphere supposedly had become fired. This naturalistic view even the self-constituted witchcraft exponent, Cotton Mather, willingly adopts in one of his books.

Priestley, the discoverer of oxygen gas, in his "History of Electricity," published in 1767, makes an interesting quotation from a paper of a certain Dr. Wall in the *Philosophical Transactions*. This Dr. Wall, an experimenter in electricity in the latter half of the seventeenth century, and a contemporary of Otto Guericke and later of Newton, after describing his experiments with rubbed amber and the production of light and the cracklings therefrom, says, "Now, I make no question but upon using a longer and larger piece of amber, both the cracklings and light would be much

greater." Then further he says: "This light and crackling seems in some degree to represent thunder and lightening." I believe this to be the first reference to the possible relationship between electricity and lightning. The later history of Franklin's suggestion of identity, D'Alibard's experiment and that of the famous kite furnishing experimental proof, are too well known to be dwelt upon here.

The practical genius of Franklin led him at once to the suggestion of protection from lightning by means of a conducting rod of metal, well connected to the moist ground at its lower end, and projecting beyond the highest parts of the building or structure to be protected. In these later years it is not unusual to meet with statements of discredit or denial of the efficacy of this simple device. There seems to be a tendency among the uninformed to regard it as an old-fashioned and useless if not a dangerous contrivance. Often the question has been asked whether it is not an exploded notion that such rods have any value for protection. It may well be that the "lightning-rod agent" of former times is largely responsible for the distrust. He was a sort of confidence man, who supplied a sham appliance, often of marvelous makeup. A structure of twisted metal tube topped with glittering gilt points in clusters, mounted on green glass insulators, the whole as extensive as the unhappy victim could be frightened into paying for, was erected, and often left without any adequate connection to the ground. It was a tree without roots; lacking, in fact, the most essential part of its structure.

Let us add with emphasis that the Franklin rod when properly installed undoubtedly secures practical immunity from lightning damage. Its installation is an engineering undertaking demanding study of varied conditions and proper care and judgment in meeting these conditions. The one consideration originally left out was that if there were any better or more direct paths for lightning existing in the building or structure or better ground connections than the rod possessed these must be included in the protective system. But it is also a fact that the construction of most modern buildings, particularly in cities, involves so much metal in roofing, ventilating and other pipes, wires and the like, that it is generally unnecessary to resort to any separate means for protection.

In cities there are many lofty structures framed in steel, piping that projects above the roof, and metal stacks, generally in good connection with the underground pipe systems; all of which together tend to minimize danger from strokes of lightning. The best vindication of Franklin will, however, be found in the fact that the firmest reliance is placed by the trained electrical engineer upon the provision of an easy path for the electricity of lightning to reach the ground. Practically all his protective appliances or arresters used in electric systems are based on that principle, with modifications and additions to suit particular conditions of use. To provide such modifications and adaptations is by no means an easy task. There is still a possibility of insufficiency such that the menace of breakdowns and damage by lightning still remains a *bête noir* to the engineer. The tremendous discharge of energy possible in a lightning stroke may be sufficient to defeat our efforts. Breaking through insulation and causing short circuits, burning of wires and rupture of circuit, and damage to apparatus are still occasional experiences in spite of our safeguards. Even at a considerable distance away a stroke of lightning, by its inductive action may set up electric waves or surgings which require to be provided against.

The extremely uncertain value of the effects, the irregularity and impossibility of calculation or prediction, render the problem of protection difficult. The effects of these secondary surges are generally incomparably less violent than direct strokes, and they are seldom dangerous to life.

So long indeed as our electric lines are extended above the ground, so long must this disturbing factor be reckoned with. Fortunately it has been possible by constant effort and study to secure more and more effective appliances so that the lightning menace grows steadily less. Research and experimentation in this direction have constituted an important part of the development of electrical engineering.

Having thus at some risk of your patience vindicated our earliest worker in the study of atmospheric electricity—Franklin—let us turn from the practical issues and consider the electricity of the air from a more general standpoint.

The study of the nature and origin of electrical storms or disturbances throughout the atmosphere is of much interest; our knowledge is yet meager; there is much more yet to be learned in this fascinating field. Exploration of the electrification of the air at varying heights by captive balloons, by kites and upon elevations of land, has generally shown an increasing electric potential upward from the earth, and usually positive in relation thereto. Sometimes this relation is reversed. It has been roughly estimated that if the differences noted can be assumed to be extended to include the total depth of the atmospheric layer, the earth's surface might be negative to the surrounding space, 150,000 volts more or less. This condition would not admit of being regarded as constant or stable, since widespread electric storms occur in both our upper and lower air levels. In the highest regions of our atmosphere they take the form of diffuse discharges as in a high vacuum and are called auroras. They either accompany or give rise to magnetic storms, which affect the direction and intensity of the earth's magnetism temporarily, and hence disturb the compass needle, sometimes through many degrees. Within a few weeks past we have experienced such a storm of a remarkable intensity; sufficient in fact to cause interruptions to telegraphic and cable transmission during several hours. Brilliant auroras were at the time seen in some places.

The frequency of auroral phenomena, and perhaps also to some extent the frequency of thunder-storms, seems to keep pace with the sunspot period, at least in our latitudes. At times of sunspot activity, the surface layers of the sun, upon the energy radiated from which so much of earthly activity depends, are stirred by great storms, or immense cyclones of hot gas or metallic vapors; storms seen as dusky spots on the sun's disc. They can attain enormous size—20,000, 30,000 or even 50,000 miles in diameter, though these dimensions are exceptional. They are visible, as is well known, not because they are non-luminous, but because they are less luminous than the surrounding solar surface. In like manner bright spots or faculæ may also be seen, because they are on the whole brighter than the sun's surface adjoining them.

There is much reason to believe that, in accordance with suggestions made many years ago, these solar storms are accompanied by exceptionally vigorous projection outward from the sun to immense distances, of streams of electrified matter. Should the earth happen to be in a position to be swept by such a stream, an aurora may be produced. During a total solar eclipse the so-called coronal streamers are seen to extend from the sun's surface to

distances of upwards of two millions of miles or possibly farther than that, but doubtless they keep on outwardly, and invisibly, to relatively enormous distances. It is not unreasonable as a hypothesis to imagine that they may extend at times as far as the orbit of the earth and may, if the direction is the proper one, reach our outer air.

Further, if they consist of electric ions or particles conveying electric charges, an aurora may result. Dr. Hale, of Mt. Wilson Observatory, has indeed recently shown by the spectroscope that great solar storms are in fact attended by the motion of electric ions at enormous velocities. The phenomena of auroras present peculiar difficulties in their study, since, as in the case of the rainbow, no two observers at a distance from each other see the same or identical appearances. Hence attempts to determine the height by triangulation at which auroras exist give most contradictory results, for it is impossible to fix upon any condensation or streamer which may not be displaced or absent to another observer some distance away. This is understood when we bear in mind that the luminous appearances are not located in one plane, but are distributed in space; condensations of light being the result of superposition in the line of observation.

I have come to the opinion that the auroral streamers often extend in a general direction outwardly from the earth, sometimes to very great distances relatively to the known extent of our atmosphere. The effects observed appear unaccountable upon any other supposition, while they are consistent with the idea of outwardly directed streams of great extent. In April, 1883, there occurred an aurora which was at its maximum a little after midnight. It was the most magnificent display of the kind, which, in spite of a continual vigilance on my part, it has been my fortune to witness. It was upon such a scale that, so to speak, the mechanism of the streamers stood revealed. At that time I could not avoid the conclusion that the auroral streamers must have extended outwardly several thousand miles. There is no space here to present the argument involved. Perhaps the most significant fact is that precisely the same general appearances were noted in Chicago as in the east, and that they occurred simultaneously. The interesting question arises, does the earth temporarily acquire streamers similar in nature to the solar coronal streamers? The answer is as yet unknown. At the time of the great display mentioned there was a sunspot near the center of the sun's disc of about 50,000 miles in diameter. During that disturbance long telegraphic lines could not be operated, owing to arcing at the keys which prevented interruption of the circuits. Apparently in subtle sympathy with its master orb, the sun, the earth's electric and magnetic equilibrium was for a time profoundly disturbed.

While it is by no means certain that auroras and magnetic storms are always dependent on solar outbursts, it is now generally recognized that the observed coincidences are too frequent to be the result of chance. It is perhaps safe to assume that although solar storms and sunspots can occur without provoking auroras or magnetic storms here, it may be doubted if these latter occur on any great scale unless solar activity is coincident therewith. And it seemingly is true that only when the projected electrified matter actually reaches the earth or comes near enough to inductively affect its electrical equilibrium are the terrestrial phenomena produced thereby.

It has even been suspected that a greater

frequency and severity of thunder-storms in our lower air accompanies the active period of the sun or sunspot maximum. This is a hypothesis which would require a careful collection and comparison of data over a long period to give it status as a scientific fact or wholly to disprove it. Be that as it may, experience with lightning damage in electric installations seemingly supports the idea, and led me in a paper given some seven or eight years ago during the minimum period, to predict a severe ordeal a few years in advance. As a matter of fact the prediction was to a large extent verified with the result of extraordinary activity in devising safeguards from which the electrical engineering art now benefits. In general the harm done by thunderstorms is due directly or indirectly to the heavy spark discharges called lightning flashes or strokes of lightning.

It may be of interest to refer briefly to the conditions existing in a cloud which is the source of such destructive energy. As is well known, clouds consist of fine water particles suspended in the air. When frozen these particles are crystalline like minute snow crystals. All clouds above the snow line are likely to be of that character. At a temperature above freezing the particles of water are microscopic spheroids which may by gradual coalescence form drops of rain. This process of coalescence necessarily diminishes the total surface of the water existing as such in the cloud. Should, however, the original particles possess even a slight electric charge, the union of the drops, by lessening the total surface, or diminishing the electric capacity, results in a great rise of potential or electric pressure on the surface of the drops. The process of coalescence continues and the water falls out of the cloud as rain. If the cloud particles are frozen the diminution of surface and consequent increase of electric pressure can not take place. This would seem sufficient to account for the general absence of thunder-storms in winter, though perhaps other causes contribute.

A thunder-cloud has been compared to an insulated charged conductor, such as a body of metal hung upon a silk cord, but in reality the two are not at all comparable. It is a mistake to assume any close analogy to exist. The cloud being only an air body containing suspended water particles, is not a conductor, nor can it, as in the case of metal, permit the accumulation of its electric charge on its outer surface. In fact it possesses no true definite outer surface but blends with the clear air around it. The electric charge it possesses remains disseminated, so to speak, throughout, and must reside chiefly upon the surface of its constituent water drops. Accumulation in any part would require the insulating air between the drops to be overcome.

A lightning stroke from such a mass may indeed represent a discharge of hundreds of amperes at millions of volts. We must, however, be cautious not to exaggerate either the current or the potential present in a lightning flash. The current in a flash can at times be only a few amperes or may in the heavier discharge reach perhaps hundreds, or possibly in extreme cases some few thousands of amperes. It is doubtful if the potential much exceeds at any time more than a few millions of volts as it is probable that small local breakdowns start the disruptive process which then extends through miles of length. The individual water particles even when collected into drops can not be charged to such enormous potentials as millions of volts. In reality it is the combined effect of the numerous particles act-

ing inductively that accounts for such pressures. A combined stress is set up towards the earth or towards another cloud mass of opposite charge. The lightning stroke results from a breakdown of the insulating air layer between them, and also all through the cloud itself, and for a time a partial neutralization or electric equilibrium is effected. This continues until a further redistribution of charges is required and until again the breakdown potential is reached. The continued coalescence of charged water particles which were not discharged at the first breakdown, repeats the original condition, and so on. Unlike the case of a suspended charged metal body, a single discharge does not usually equalize the electric potential of cloud and earth. Instead, many successive discharges occur. It is probably fortunate for us that the process is as gradual as it is, for the ordinary partial discharges of the cloud are each terrific enough and tax our resources sufficiently when we seek to protect ourselves and our effects from them.

Various hypotheses have been proposed to account for the presence of electric charges in cloud masses, but there is no time to discuss them here, and there is in fact little that is really known as to the origin of the electricity of clouds. We shall briefly refer to the phenomena which characterize or accompany the electric discharges. The usual form which the discharge takes is that known as disruptive spark or fork lightning, a long flash or electric spark, joining earth and cloud, or cloud and cloud, and branching within the cloud mass like a tree. Oftentimes between cloud and earth there is seen the single streak zigzag in its course, but within the cloud it ramifies or branches extensively in several directions. In this way only can any considerable part of the cloud contribute its portion to the main discharge path, for, as stated before, the cloud can not act as a conducting body.

Some authorities treat lightning as a discharge of very high frequency like the ordinary discharge of a condenser or Leyden jar. In fact it has not been unusual to assume that such apparatus can be substituted and inferences drawn as to the nature and character of the lightning discharge from experimentation and tests with these laboratory appliances. There is, however, abundant reason to doubt that lightning discharges are really oscillatory. If they oscillate the conditions are such as to forbid such oscillation being of a high frequency order. The cloud discharge represents what is known as a discharge of a large capacity, and the length of the path or spark may reach thousands of feet or even many miles; a long inductive path, while the heat and light given out in every part of the path indicate a high resistance to the passage of the discharge. All of these conditions are together known to be inconsistent with the idea of high frequency oscillation. But the breakdown or discharge is extremely sudden and involves an almost instant rise of the current to a large value, so that the inductive effects upon surrounding structures, such as electric lines or circuits, are very energetic and sharp like a quick blow struck; and these lines or structures become the seat of rapid vibration or high frequency oscillations. The sudden blow of the hammer on a bell in like manner brings out all the rates of the vibration, fundamental and overtones, of which the bell is capable and in which the hammer itself takes no part.

The very sudden startling character of a lightning discharge leads to an exaggeration in the popular estimate of its more evident effects. The amount of light

given out is not so great as is often assumed. It does not give effects at all comparable with full sunshine. While doubtless the intrinsic brilliancy is very high the duration of the flash is small, generally only a minute fraction of a second. In photographs of lightning the landscape is generally seen only in outline or poorly lighted by the discharge. In the daytime, when the clouds are not dense enough to greatly darken the sky, the flash loses most of the blinding character it has when seen in the blackness of night. Similarly, the sound of thunder, though of terrifying quality, is not extraordinarily loud. It is a common experience when traveling in a train to note that the sound of even near-by flashes is smothered by the roar of the train so that no thunder is heard. The noise of thunder can not be due in any part, as is sometimes erroneously assumed, to collapse of the air upon itself and into a partial vacuum left by the spark. I have seen this error even recently repeated and even extended to include all the noise of thunder as due to such collapse. When, however, we consider that in a minute fraction of a second the air in the path of the discharge is so highly heated that, if it were confined, its pressure due to heat expansion alone would rise to more than ten atmospheres we can readily understand the explosive shock given to the surrounding air and the propagation therethrough of an intense air wave. In fact such waves from electric spark discharges and from dynamite explosions have been clearly recorded by photography. Moreover, that the collapse of the air after expansion can have little or no effect in the sound production, follows from the fact that the heated gas streak left in the path of the discharge takes an appreciable time to cool on account of its low radiating power. This is shown by the observation that a lightning discharge in dusty air is often succeeded by a luminosity of the streak which persists for a perceptible time and slowly fades away like the luminous trail of a meteor.

Another common misconception is that the prolonged rolling character of thunder is due to reverberations or echoes. In mountain regions with steep rock walls such reverberations possibly contribute to the effect, but it is now clearly recognized that a sufficient single explanation suffices for most cases. Owing to the great length of the lightning spark or path, we receive the sound from the nearer parts of the discharge far in advance of that from the more remote portions, and between these sounds are those from parts of the path at intermediate distances from the observer. It follows from this that no two observers at a distance from each other hear the same succession of sounds in the thunder of a discharge. Whenever portions of the discharge path are situated or extended in an approximate direction at right angles to the line from the observer, the sound from that part of the path is louder or of high amplitude owing to the sound from that part of the path reaching the observer's ear at the same instant. Whenever the path leads directly away from the observer the amplitude is less, the sound is less explosive and takes the character of an extended roll or rumble.

It will be seen from this that every twist and turn and every change of direction of the spark path with respect to the observer's position gives a varying loudness and sequence of sounds. Every branch of the main discharge in like manner records its position and direction, its twistings and bendings in these sound vibrations and sequences. It would seem possible even to record on a phonograph noises from sparks invisible to the eye and map the positions

of the sparks in space from records so produced. If this were done as it were stereoscopically or stereographically from two or more separated observing or recording places, the records would contain the necessary data for the reconstruction of the spark and its branches in space.

From the above considerations an attempt to determine the distance of a lightning stroke to earth by counting seconds elapsing between the flash and the first thunder and allowing five seconds to a mile approximately is seen to be futile. Should one of the cloud ramifications or branches of the great tree-like discharge extend in the cloud overhead with relation to the observer, and that part of the discharge be nearer to him than any other he will first hear a receding rumble above him, followed it may be by a heavy explosion from the main or approximately vertical spark between cloud and earth and from the parts of which his distance is nearly the same. This louder explosion will then be followed generally by a prolonged rumble of diminishing loudness which is the sound coming from the ramifications which lead farther to the distant parts of the cloud. Manifestly the counting of time should be between the flash and the heavy explosive sound due to the vertical part of the flash.

Bearing in mind that over the extent of cloud the charged water particles may be said to be waiting for a chance to discharge to earth, it is not surprising that any path which has been opened or broken down by disruption of the insulating layer of air should serve for the discharge of an extended body of cloud. The heated vapor or gas in the path of the discharge is a relatively good conductor of electricity serving to connect the cloud mass to the earth below. The significance of this is understood when it is known that many lightning discharges are multiple. Instead of a single discharge they consist of a number rapidly following one another through the path or spark streak opened to them by the first discharge. This first discharge opens the way or overcomes the insulating barrier to the discharge of portions of the cloud mass, which, on account of remoteness or lower potential, could not themselves have caused the breakdown. These repeated or multiple flashes are exceedingly dangerous, both to life and property. The first discharge may reduce wood to splinters and the subsequent ones set it on fire. The time interval between the successive discharges in such a multiple flash is quite variable and may be long enough to be easily perceptible by the eye. The multiple character is easily disclosed by the image in a revolving mirror. If a strong wind be blowing at the time of such a multiple flash, the hot gas conducting the discharges may be displaced laterally in the direction of the wind with the result of spreading out the discharges into a ribbon more or less broad. Photographs of these ribbon flashes show their true character plainly; each separate discharge appearing as a streak of light parallel to the others and at varying distances apart. In fact parallel discharges of exactly the same contour are sometimes observed many feet apart. Here the hot gas of the first discharge has evidently been shifted by the wind over a considerable space before the second and subsequent discharges took place. Heavy rain seems to weaken the air and help to precipitate a discharge. From the fact that strokes of lightning are often followed by increased fall of rain within a few seconds it is a prevalent idea that the increased downpour is caused by the discharge. In reality the reverse is the case, for just when a gush of rain has reached from the cloud down to within a

hundred feet or more from the ground, by far the major part of the air layer has been so weakened electrically by the presence of the water drops, that the discharge itself anticipates the completion of the distance of fall of the rain, and is therefore a short time in advance of the time when the descending gush of rain actually reaches the ground. As the gusts or gushes of rain are more or less local and sweep along with the storm cloud, they are apt to mark out the places of the most frequent lightning strokes. Shelter sought at such times under tall trees is particularly dangerous.

The amount of energy which may be concerned in a lightning discharge is neither definite nor capable of estimation. It would seem that the widest variations in energy may occur and this would account largely for the observed differences in the severity of the effects. It must be remembered also that by far the larger part is expended in the long spark in the air and cloud. Even when much damage is done to objects struck it is only a small fraction of the total energy which is expended on them. Most of the damage to property comes indirectly from the electric discharge by its energy being instantaneously converted into heat. This heat evolves steam and expanded gases in the interior of such materials as wood and causes explosion, shown in the splintering or rupture.

A curious effect, often noted when a tree is struck and shattered, is that when the splinters, sometimes of large size, are thrown bodily out to distances of many feet from the shattered tree, the splinters in their movement remain in parallel to the tree and in a vertical position. They are frequently found standing upright after a stroke and at distances ranging up to sixty or eighty feet away. This fact indicates that the projecting force is quite instantaneous and is exerted equally and at the same moment throughout the length of the splinter in a direction transverse to its length. Such splinters are sometimes ten or twelve feet in length and several inches thick. As will be seen, a person near a large tree which is so disrupted is in danger of being struck in a different way, even if he escapes being included in the path of the stroke itself. Aside from this mechanical danger it is known that to take refuge under a tall tree during a heavy thunderstorm is particularly hazardous. This is so because the human body is a better conductor than the tree trunk, particularly as the trunk itself is the last part to become thoroughly wetted by the rain. The leaves and upper parts are wet and more or less conducting while the tree trunk itself may be yet dry. In such a case the body of a person forms a good path or shunt to the dry trunk and is therefore particularly apt to be traversed by any stroke which reaches the tree.

As before indicated, damage to buildings and other such structures can in all cases be prevented by the provision of an effective shunting path to earth. A most essential feature of such a structure as the Franklin conductor is its good connection with the ground, or better its connection with what we know as a good ground. In early times it was considered that it was quite important that the tip or upper end of the conducting rod should be sharply pointed, or should bristle with sharp points, so to speak. The tips were gilded and the points made of gold or platinum to prevent rusting. The points were supposed to draw off the lightning silently from the cloud and so prevent strokes of lightning. But for millions of volts at cloud distances almost all irregular objects on the surface of the earth are practically pointed. Perhaps on this erroneous assumption of the action of points as applied here little stress

was laid on the direct path to earth being chosen and on the necessity of including with it or connecting to it other good paths such as gas pipes, bell wires and the like. There is no need of any special provision of points. A blunt end will do as well, for after all there is practically no silent drawing off of the charge from the cloud, for it is not an insulated conductor. The provision of a lightning conductor on a building undoubtedly increases its chances of being struck by lightning, but if properly arranged it also ensures that the structure shall suffer no harm therefrom. Viewed from our present standpoint it is a curious historical fact that in 1777, just after the war of the American revolution broke out, a miniature verbal war between the advocates of *blunts* and *points,* respectively, as applied to lightning conductors raged. In England party politics led many to condemn *points* as revolutionary and stick to *blunts.* The Royal Society by majority vote decided for points, but those who so voted were considered friends of the rebels in America. George III. took the side of *blunts.* Franklin, who from the first had prescribed points, wrote from France: "The King's changing his pointed conductors for blunt ones is a matter of small importance to me. For it is only since he thought himself safe from the thunders of Heaven that he dared to use his own thunder in destroying his own subjects." The king is reputed to have tried to get Sir John Pringle, then president of the Royal Society to work for blunts, but received the reply: "Sire, I can not reverse the laws and operations of nature." As stated above, it matters not at all which we may use. I have, indeed, seen a number of cases in which the sharp points of lightning conductors had been melted into rounded ends by lightning.

In the foregoing we have been considering the effects of such ordinary discharges of electricity as the disruptive spark, or zigzag flash. Apparently if the testimony is reliable there are other and more rare forms of discharge. I allude to sheet lightning, so-called globular lightning and to bead lightning. But it may be asked, why call sheet lightning a rare form? It is, indeed, true that when a storm is so far distant that the spark discharges can not be seen, as when it is below the horizon, or when the spark is blanketed by a mass of mist or cloud there is to be noted a diffused light or extended illumination, which, on account of distance, may not appear to be attended by thunder. This and similar effects are often called sheet lightning. From observations during a few heavy storms, however, I am led to infer the existence at rare intervals of a noiseless discharge between cloud and earth—a silent effect attended by a diffused light, and which may be the true sheet lightning. In my experience it has accompanied an unusually heavy downpour of rain, the whole atmosphere where the rain fell most heavily being apparently momentarily lighted up by a purple glow, seemingly close at hand in the space between the rain drops. The appearance has been seen in the daytime as an intense bluish or purplish momentary glow without any accompanying sound. It could scarcely have been illusory. It is hoped that other observers will carefully note any such like effect if it occurs. It is certainly a rare phenomenon.

It is quite common that any very bright flash, the details of which from its suddenness and intensity are unobservable, be alluded to as a ball of fire. Doubtless many of the reported cases of so-called ball or globular lightning may be explained as instances of this condition of things. Nevertheless, there are so many recorded instances, apparently in substantial agree-

ment, that it is difficult to escape the conclusion that there in reality exists this rare form of electric effect, globular lightning.

We can not properly discredit observations of phenomena which are so rare that our own chance for confirmation of them may never come. We must, in such cases, carefully scrutinize the testimony, examine the credibility of witnesses and their chances of being mistaken. It is certainly impossible at present to frame any adequate hypothesis to account for this curious and obscure electric appearance. The witnesses agree that it is an accompaniment of thunder-storms and that it resembles a ball of fire floating in the air or moving along a surface, such as the ground. It is not described as very bright or dazzling, and the size of the ball itself may be from an inch or two to a foot or more in diameter. Observers agree that it can persist for some time and that its slow movement allows it to be readily kept under observation while it lasts. When it disappears there is usually an explosion and a single explosive report like that of gun fire. Sometimes it is said to disappear silently. Usually the damage done by its explosion is only slight. This summary of characteristics is common to all accounts. Some accounts are even more detailed, mentioning that the fiery ball seemed to be agitated or with its surface in active motion. I have found two instances occurring many years apart and in widely different localities in which it is described as having a reddish nucleus, in diameter some considerable fraction of the whole. The outer fiery mass has been described as yellowish in color. In some instances it has been seen to fall out of a cloud. It is described as entering buildings and moving about therein. Personally I was for a long period in doubt as to the reality of this strange appearance, deeming it the result of some illusion, or a fanciful myth. But on hearing descriptions by eye witnesses known to me as persons not given to romancing, and finding their accounts to correspond closely with the best detailed descriptions in publications, my doubts have disappeared.

In one instance, while observing the lightning during a heavy thunderstorm, a companion, whose eyes were turned in a direction nearly opposite to my own, suddenly called to me that a ball had just dropped out of the cloud some distance away. The view of the ground was obstructed by buildings and I unfortunately just missed it. The noise of its explosion was, however, heard in the direction indicated by my fellow observer, as a single report like the firing of a gun. At the time I closely questioned him as to details of the appearance. Our ignorance of its possible nature is complete. No rational hypothesis exists to explain it. Science has in the past unraveled many obscure phenomena. The difficulty here is that it is too accidental and rare for consistent study, and we have not as yet any laboratory phenomena which resemble it closely.

Sometimes photographs taken during thunder-storms have been found to carry curiously contorted streaks in some degree resembling lightning flashes. Generally they have been found on plates upon which undoubted lightning discharges have been recorded. In some instances which have come to my notice the streaks have had the appearance of a string of dots or beads and have been taken to represent a very rare form of lightning known as bead lightning. A number of such photographs have been submitted to me for opinion as to the nature of the curious streaks. In all cases they are explained as due to the camera having been moved without capping the lens, permitting images of lights, such as arc lights, or spots of reflected

light from wet or polished surfaces to traverse the plate in an irregular course. They are then only records of the inadvertence of the lightning photographer. In one instance the effect was so curious that it was several years before the true explanation was found. In that case there were two wavy contorted streaks of perfectly parallel and of similar outline, but unequal in intensity, rising each from a rail of a single track railway, and apparently terminating in the air fifteen or twenty feet above the tracks. They were finally traced to a moving camera, and a reflection from the wet and polished rail surfaces of the light of an arc lamp located outside the field of view. It required a visit to the place itself to enable this conclusion to be reached. The particular beaded streaks or lines of dots were traced to the fact that the arc lamps causing them were operated by alternating currents which naturally give light interrupted at the zero of current; one hundred and twenty times per second being the usual rate. All this emphasizes the need of care and wholesome scrutiny or even skepticism before reaching a conclusion in such cases.

Is bead lightning, which has at times been described as observed visually, a reality? If it is it appears to be even rarer than the globular variety. Perhaps it is a string of globules; a variety of globular lightning. But we can not make assumptions. As in the case of globular lightning there is some testimony, which can not be wholly disregarded, tending to show that a form of discharge resembling a string of beads can actually exist. An account of an instance was given me within one hour after the occurrence itself. The witness was known to me as perfectly reliable. The appearance was described as a festoon of finely colored oval beads hung as it were from one part of cloud to another, and as persisting for some seconds while gradually fading away. The opposite ends of each bead were said to be different in color. It was seen during an afternoon thunderstorm and spoken of as very beautiful, and altogether different from the usual zigzag flash.

If I have dwelt upon these exceptional appearances at some length it is because they seem to show that in electricity there is much yet to learn and abundant opportunity for future investigation. It is certainly literally true that, in the language of Shakespeare, "There are more things in Heaven and earth, Horatio, than are dreamt of in your philosophy." Such work belongs to the science of physics, now recognized as fundamental in all study of nature's processes. In electrical engineering, which is in reality an art based upon applied physics, the subject of lightning protection has always been one of considerable if not vital importance. Just as a lightning discharge from a cloud clears up a path for other discharges to follow, so in electric undertakings it opens up paths for the escape of the electricity we are sending out to do the work intended, such as for lighting, power or other use. In the past, disablement of machinery in electric stations has not been rare. The recent growth of long-distance transmission involving hundreds of miles of wire carried on poles across country, over hills and through valleys, has set new problems of protection, and called for renewed activity in providing means for rendering the lines and apparatus immune to the baneful effects of electric storms. Judging the future by the past, we may conclude that, whatever difficulties of the kind arise, in the great future extensions of such engineering work, science and invention will provide resources ample for the needs, and the rapid advance will be continued unchecked.

ELIHU THOMSON

PRESIDENT TAFT'S MESSAGE

Paragraphs of special interest to scientific men in President Taft's annual message to the congress concern the U. S. Naval Observatory and a Bureau of Health. They read as follows:

The generosity of Congress has provided in the present Naval Observatory the most magnificent and expensive astronomical establishment in the world. It is being used for certain naval purposes which might easily and adequately be subserved by a small division connected with the Navy Department at only a fraction of the cost of the present Naval Observatory. The official Board of Visitors established by Congress and appointed in 1901 expressed its conclusion that the official head of the observatory should be an eminent astronomer appointed by the President by and with the advice and consent of the Senate, holding his place by a tenure at least as permanent as that of the superintendent of the Coast Survey or the head of the Geological Survey, and not merely by a detail of two or three years' duration. I fully concur in this judgment and urge a provision by law for the appointment of such a director. It may not be necessary to take the observatory out of the Navy Department and put it into another department in which opportunity for scientific research afforded by the observatory would seem to be more appropriate, though I believe such a transfer in the long run is the best policy. I am sure, however, I express the desire of the astronomers and those learned in the kindred sciences when I urge upon Congress that the Naval Observatory be now dedicated to science under control of a man of science who can, if need be, render all the service to the Navy Department which this observatory now renders, and still furnish to the world the discoveries in astronomy that a great astronomer using such a plant would be likely to make.

* * * * *

For a very considerable period a movement has been gathering strength, especially among the members of the medical profession, in favor of a concentration of the instruments of the national government which have to do with the promotion of public health. In the nature of things, the medical department of the army and the medical department of the navy must be kept separate. But there seems to be no reason why all the other bureaus and offices in the general government which have to do with the public health or subjects akin thereto should not be united in a bureau to be called the Bureau of Public Health. This would necessitate the transfer of the Marine Hospital Service to such a bureau. I am aware that there is a wide field in respect to the public health committed to the states in which the federal government can not exercise jurisdiction, but we have seen in the Agricultural Department the expansion into widest usefulness of a department giving attention to agriculture when that subject is plainly one over which the states properly exercise direct jurisdiction. The opportunities offered for useful research and the spread of useful information in regard to the cultivation of the soil and the breeding of stock and the solution of many of the intricate problems in progressive agriculture have demonstrated the wisdom of establishing that department. Similar reasons, of equal force, can be given for the establishment of a Bureau of Health that shall not only exercise the police jurisdiction of the federal government respecting quarantine, but which shall also afford an opportunity for investigation and research by competent experts into questions of health affecting the whole country, or important sections thereof, questions which, in the absence of federal governmental work, are not likely to be promptly solved.

THE GEORGE CROCKER SPECIAL RESEARCH FUND

By the will of the late George Crocker, of New York City, valuable property, said to be worth about $1,500,000, has been bequeathed to Columbia University for researches on the cause, prevention and cure of cancer. The clause in the will relating to this bequest is as follows:

I order and direct my executors hereinafter named to sell my land, corner of Sixty-fourth Street and Fifth Avenue, in the Borough of Manhattan, City of New York, together with the house thereon, known as No. 1 East Sixty-fourth Street, and the contents thereof, as well as all my real estate at Darlington, in the County of Bergen, State of New Jersey, together with the houses thereon and the contents thereof, and the horses, cattle and other personal property connected therewith, and to convert the same into money and pay the net proceeds thereof to the trustees of Columbia College in the City of New York, to be held by such trustees and invested as a permament fund, to be known as the "George Crocker Special Research Fund," the income of which shall be applied in such manner as said trustees may

from time to time determine in the prosecution of researches as to the cause, prevention and cure of cancer, and, should the progress of science at any time make the prosecution of further research in regard to cancer unnecessary, then the income of said fund may be used as said trustees may from time to time determine in the prosecution of other researches in medicine and surgery, and in the science allied thereto, with a view of preventing and curing diseases and of alleviating human suffering.

Provided, however, that no part of the principal or income of this fund shall be at any time used for the erection of a building.

CHANGES AT HARVARD COLLEGE

AT a meeting of the Board of Overseers of Harvard College, held in Boston, December 8, 1909, the president of the university communicated the following votes of the faculty of arts and sciences modifying the choice of electives:

1. That a standing committee of nine, of which the president shall be chairman, be appointed from the faculty, with power to associate with itself a large number of advisers for students.

2. That the committee prepare general rules for the choice of electives, to be approved by the faculty, based upon the principle that a student must take a considerable amount of work in some one field, and that the rest of his courses must be well distributed.

3. That at the end of his first year in college each student be required to present to his adviser a plan of study for the remainder of his college course; and that the plan must conform to the general principles laid down by the committee, unless the committee is satisfied that the student is earnest and has sufficient grounds for departing from those principles.

4. That a student's plan be subsequently changed only for a cause satisfactory to the committee.

And after debate thereon, the board unanimously approved said votes, and authorized the carrying out of the same.

The president of the university communicated orally to the board the contemplated establishment by the corporation of a freshman dormitory, and explained the purpose and scope of the same, and after debate thereon, the board unanimously voted to approve the establishment of the said dormitory as contemplated by the corporation.

EDUCATION AT THE BOSTON MEETING OF THE AMERICAN ASSOCIATION

MEMBERS of the American Association who are interested in education as well as in science will find much in the program of the Boston meeting to attract them. Because of the establishment of the section of education a number of educational interests are grouping themselves around the American Association, and this manifests itself in the program of the coming meeting by the fact that there are educational meetings scheduled for nearly every morning and afternoon of the session.

Section L itself will hold three sessions. The first of these on Tuesday afternoon will be devoted to the discussion of scientific problems in general education by members of the section. On Wednesday afternoon reports will be made by the General Education Board, the Carnegie Foundation for the Advancement of Teaching and the Bureau of Education on their studies of the American college. At 4.30 on that day, Professor Dewey, the retiring vice-president, will deliver his address on "Science as a Method of Thinking and as Information in Education." On Thursday morning the committee on the Distribution of Students in Elective Courses will present its report.

The section will hold also two joint meetings; one on Tuesday morning, with the American Federation of the Teachers of the Mathematical and Natural Sciences, to which preliminary reports from several of the section committees of the International Commission on Teaching Mathematics will be presented and other topics of general interest to science teachers discussed. The other will be held on Wednesday morning with the Social Education Club of Boston and will be devoted to the discussion of the problem of social education.

Besides these meetings, a number of others have been arranged by the local associations of teachers and by other sections of the association. Section A will listen to a prelim-

inary report from the International Commission on the Teaching of Mathematics; and Section B plans to devote one session to a discussion of the teaching of physics. The Social Education Club, of Boston, plans to hold one evening meeting with a program that should be of particular interest. The Eastern Association of Physics Teachers, the Association of Mathematical Teachers in New England and the Association of Physics Teachers of Washington expect to hold meetings and render programs that will be valuable to those interested in educational matters.

The American Federation of Teachers of the Mathematical and Natural Sciences will hold its annual business meeting on Monday afternoon. The American Nature Study Society will meet on Saturday morning to discuss the problem of physical nature study. All of these meetings are open to the public.

THE AMERICAN PHYSIOLOGICAL SOCIETY

The preliminary program of the twenty-second annual meeting to be held at the Harvard Medical School, Boston, December 28–30, is as follows:

Tuesday, December 28

9:00 A.M.—Reading of papers, followed by a business session after 12 o'clock.

2:30 P.M.—Meeting of Section K—Physiology and Experimental Medicine—American Association for the Advancement of Science. (Lecture Room, Building, of Harvard Medical School).

Address of the retiring vice-president, W. H. Howell.

Discussion of the Ductless Glands.

R. H. Chittenden, General Chemical Aspect of Internal Secretion.

S. P. Beebe, Thyroid.

J. V. Cooke, Parathyroid.

Harvey Cushing, Hypophysis.

W. G. MacCallum, Pancreas.

Swale Vincent, Suprarenal.

8:30 P.M.—Joint smoker with the Association of American Anatomists and the American Society of Biological Chemists at the Hotel Westminster, Copley Square.

Wednesday, December 29

9:00 A.M.—Joint session of the American Society of Biological Chemists and the American Physiological Society.

2:00 P.M.—Visit to the Carnegie Nutrition Laboratory (by invitation of Dr. F. G. Benedict).

3:00 P.M.—Physiological demonstrations (Harvard Physiological Laboratories).

Thursday, December 30

9:00 A.M.—Reading of papers, followed by a business session after 12 o'clock.

2:00 P.M.—Demonstrations.

THE AMERICAN SOCIETY OF NATURALISTS

The American Society of Naturalists will meet at the Harvard Medical School, Boston, Mass., on Wednesday, December 29, 1909.

The program will consist of original papers and demonstrations of studies on evolution. The following papers are promised and a few others will probably be added to the list:

E. M. East: "A Mendelian Interpretation of Variation that is apparently Continuous."

J. B. Watson: "The Problem of Determining Color Vision in Animals."

W. L. Tower: Title not yet received.

G. H. Shull: "The Inheritance of Sex in *Lychnis alba*."

Frank E. Lutz: "Experiments concerning the Reversion of Domesticated Races to the Wild Type."

W. J. Spillman: "Mendelian Phenomena Independent of de Vriesian Hypotheses."

J. Reighard: "Biological Meaning of Conspicuousness in Animals."

T. H. Montgomery: "Sexual Selection in Spiders."

D. H. MacDougal: "Origination of Parasitism in the Higher Plants."

Anne M. Lutz: "The Relation of Chromosome Number to Vegetative Characters in the *Œnothera*."

H. S. Jennings: "Experimental Evidence on the Effectiveness of Selection."

C. H. Eigenmann: "The Divergence and Convergence in Characins."

Ulric Dahlgren: "Origin of the Electric Tissues in Teleost Fishes."

W. E. Castle: "On the Nature of Mendelian Factors."

R. R. Gates: "The Material Basis of Mendelian Phenomena."

E. Brainard: "The Evolution of New Forms in *Viola* through Hybridism."

A. F. Shull: "The Artificial Production of the

Parthenogenetic and Sexual Phases in the Life Cycle of *Hydatina senta*."

Franz Boas: "The Influence of Heredity and of the Environment on Man."

C. W. Beebe: "Racket Formation in the Tail Feathers of the Mot-mot."

Most of the papers will be illustrated by actual specimens or other demonstrations and time will be allowed for discussion. The society will probably meet in two sessions, morning and afternoon.

The Naturalists' dinner will be held on the evening of Wednesday, December 29, when the address of the president, Professor T. H. Morgan, will be delivered on "Chance or Purpose in the Evolution of Adaptations."

As previously, members of the special societies devoted to biological sciences are invited to attend the dinner of the naturalists.

Those expecting to attend the dinner will greatly oblige the committee in charge, if they will notify Dr. R. P. Bigelow, Massachusetts Institute of Technology, Boston, Mass., at the earliest opportunity.

H. McE. KNOWER,
Secretary

SCIENTIFIC NOTES AND NEWS

THE Nobel prizes for the present year have been awarded as follows:

For Physics—Divided between Mr. Guglielmo Marconi and Professor Ferdinand Braun, of Strassburg.

For Chemistry—Professor Wilhelm Ostwald, of Leipzig.

For Physiology or Medicine—Professor Theodor Kocher, of Berne.

For Literature—Selma Langerlof, the Swedish authoress.

For the Promotion of Peace—Baron D'Estournelles de Constant, president of the French parliamentary group for international arbitration, and M. Beernaert, former Minister of State of Belgium.

THE address of the retiring president of the American Association for the Advancement of Science, Professor T. C. Chamberlin, of the University of Chicago, will be given in Sanders Theater, Harvard University, on Monday evening, December 27, and will be followed by a reception in Memorial Hall.

DR. MAX VERWORN, professor of physiology in the University of Göttingen, will be the next Silliman lecturer at Yale University.

THE medical faculty of the University of Budapest has offered the chair of experimental biology to Professor Jacques Loeb, of the University of California. Professor Loeb lectured before the International Medical Congress at Budapest last September and delivered a course of lectures at the University of Budapest in June.

MR. FRANCIS DARWIN, F.R.S., has been made doctor of the University of Brussels and a corresponding member of the Institut National of Geneva.

A COMMITTEE has been formed at Cambridge to present a portrait to Mr. A. E. Shipley, F.R.S., lecturer in natural science at Christ's College and university reader in zoology.

THE American Institute of Electrical Engineers has appointed Professor A. E. Kennelly, of Harvard University, president of the United States national committee of the international electrotechnical commission.

THE Royal Meteorological Society has awarded the Symons gold medal to Dr. W. N. Shaw, F.R.S., in recognition of his work for meteorology.

SINCE the return of the DeMilhau Peabody Museum South American Expedition, Dr. William C. Farabee has received from the *Universidad Mayor de San Marcos de Lima* a diploma as honorary member of the faculty of sciences in the university, for "scientific merits and important services rendered to the government of Peru." Besides the formal communication from the university, a personal letter from the president of the republic accompanied the diploma.

MAJOR CHARLES E. WOODRUFF, of the medical corps of the U. S. A., has been detailed as the medical officer in charge on the Island of Corregidor, at the mouth of Manila Bay, where extensive fortification construction is being done.

DR. WALTER LEHMAN, of the Royal Ethnographical Museum, of Berlin, has returned from an expedition to Central America and

Mexico and is at present working in the museums of this country.

At the meeting of the American Philosophical Society on December 17, the annual address of the president will be given by Dr. William W. Keen, and a historical paper will be presented by Dr. Eduard Meyer, professor of ancient history in the University of Berlin.

The annual public address under the auspices of the Entomological Society of America will be given this year, on the evening of Thursday, December 30, by Dr. John B. Smith. The title is "Insects and Entomologists: their Relation to the Community at Large." Members of the American Association and of the affiliated societies and the public in general are cordially invited to attend.

Dr. L. A. Bauer gave an illustrated address at the annual meeting of the Washington Society of Engineers on December 7, on "The Non-magnetic Yacht *Carnegie* and her Producer Gas Engine."

On Friday, December 3, Professor J. A. Holmes, of the U. S. Geological Survey, lectured before the students of the College of the City of New York on "Explosions in Coal Mines."

The Huxley lecture at Birmingham University was delivered on December 1 by Professor W. Bateson, F.R.S., his subject being "Mendelian Heredity."

We learn from *Nature* that the meeting of the Royal Irish Academy on November 30 was occupied by a commemoration of Charles Darwin, the date nearly coinciding with that of the publication of "The Origin of Species" fifty years before. The president, Dr. F. Tarleton, opened the proceedings, and the following short addresses were given on the influence of Darwin's work: Geology, Professor G. A. J. Cole; geographical distribution of animals and plants, Dr. R. F. Scharff; zoology, Professor G. H. Carpenter; botany, Professor T. Johnson; anthropology, Professor A. F. Dixon.

The collection of lichens formed by the late Clara E. Cummings, Hunnewell professor of cryptogamic botany at Wellesley College, has been bought by the college and will be installed in the department of botany as a memorial to Professor Cummings.

By subscription a fund has been created in honor of Dr. Christian Fenger, of Chicago, who died in 1902. The fund is to be known as the Fenger Memorial Fund and the income is to be used to promote medical investigation. The directors of the Fenger Memorial Association have set aside $400 for this purpose for 1910. Applications with the necessary details should reach the secretary, Dr. L. Hektoen, 1743 W. Harrison Street, Chicago, not later than February 1, 1910.

A scholarship in engineering at the University of Pennsylvania has been founded by Mrs. S. W. Carlton, Jr., in memory of her father, the late Dr. Coleman Sellers, the eminent engineer.

Dr. Jean Binot, head of the department of pathological anatomy of the Pasteur Institute, Paris, died at the end of November.

The new administration building of the Carnegie Institution of Washington, situated at Sixteenth and P Streets, will be open to the public for inspection on Wednesday, Thursday and Friday, December 15, 16 and 17, from 2 to 5.30 P.M. Opportunity will also be offered to view an exhibit of the work of the institution and its departments.

Section B, of the American Association and the American Physical Society, will meet on Tuesday, December 28, in the Lowell (new) Lecture Hall, Cambridge, where the vice-presidential address will also be given on Tuesday afternoon. The Wednesday, Thursday and Friday sessions of Section B and the American Physical Society will be held at the Institute of Technology, as previously announced. Dr. L. A. Bauer, chairman of the section, has addressed to physicists the following letter:

It gives me much pleasure to announce that, judging from present indications, our coming meeting at Boston will be a success. Titles of papers have already been received from eminent physicists, among them Michelson and Runge, of Göttingen.

For one reason or another some of our foremost

investigators have not always attended the American Association for the Advancement of Science meetings and have, in fact, been known to speak disparagingly of them. However, it should be remembered that it lies within our own power to make the meetings just what we want them to be. I, for one, believe that we have sufficient talent on this continent to make our gatherings as successful as the recent one of the British Association for the Advancement of Science at Winnipeg.

If you have an important contribution to make let me urge you to forward immediately the title and abstract to one of the secretaries and above all to lend encouragement by your presence. It is hoped that our meeting will be truly one of "general consultation, a focal point for condensed opinions, for authoritative statements, for criticism from varied standpoints," as also of friendly intercourse among sympathetic workers.

If you are not already a member of the American Association for the Advancement of Science it behooves you to become so at the earliest possible date.

"I hold every man a debtor to his profession; from the which as men of course do seek to receive countenance and profit, so ought they of duty to endeavor themselves by way of amends to be a help and ornament thereunto."—*Francis Bacon.*

THE department of plant pathology of the New York State College of Agriculture, at Cornell University, announces the establishment of a second temporary industrial fellowship. This fellowship, which is known as the C. W. Stuart & Company Fellowship has been established by C. W. Stuart & Company, nurserymen, of Newark, N. Y. The purpose of this fellowship is the investigation of the diseases of nursery stock with particular reference to the fire blight or pear blight disease. This fellowship carries an annual salary of $500 per year and $250 per year for carrying on the work and is to continue for two years. Mr. V. B. Stewart, A.B. (Wabash, '09), has been appointed fellow. He spent the summer of 1909 in one of the nurseries of this company.

MR. ZACCHEUS DANIEL, Thaw fellow in astronomy at Princeton University, discovered a new comet on December 6, while working in the Prospect Avenue Observatory. It is of about the ninth magnitude, the nucleus being of about the thirteenth magnitude. The position was Dec. 7.8759 Greenwich meantime, R. A. $6^h\ 16^m\ 44^s.0$, Dec. $+34°\ 55'\ 15''$.

THE Astronomical and Astrophysical Society of America through its Comet Committee is soliciting cooperation in the observation of Halley's comet at its approaching return, and has prepared a circular letter of advice with regard to such observations that has been widely distributed among observatories. A copy of this circular will be mailed to any astronomer who may desire to use it, upon request being made to the chairman of the committee, Professor G. C. Comstock, Washburn Observatory, Madison, Wisconsin. Among the matters treated in the circular are: Photographing Comets by Professor Barnard, Spectroscopic Observations by Professor Frost, Photometric Observations by Professor E. C. Pickering, etc. It is the purpose of the Comet Committee to collate as far as possible the photographic results obtained and for that purpose it would be pleased to receive copies (positives on glass) of photographs of the comet from all parts of the world. This wide distribution of photographic observations is regarded as a matter of prime importance and in order to obtain them where they would otherwise be lacking, in the broad expanse covered by the Pacific Ocean, the committee, aided by a grant from the National Academy of Science, at Washington, is preparing to send out to the Hawaiian Islands an expedition that will have as its sole purpose the photographing of the comet during the months of its greatest brilliancy, March to June, 1910.

THE following scientific papers have been given during the months of October and November at the meetings of the University of Colorado Scientific Society: "The Darwin Celebration, Cambridge," Professor T. D. A. Cockerell; "Comets; with special reference to Halley's Comet and its approaching return," Professor Oliver C. Lester; "Forests and Stream Flow," Professor Clement C. Williams; "Rabies," Dr. A. R. Peebles; "The Conservation of Human Life—More important than that of Forests, Waters, Soil or Minerals," Professor Francis Ramaley.

The annual joint meeting of the Iowa Society of the Archeological Institute of America, the Iowa Anthropological Society and the Iowa branch of the American Folk-Lore Society, was held at the State University of Iowa, November 26 and 27. At the opening session on Friday afternoon, a greeting was extended to the visitors by President George E. MacLean, of the university, which was responded to by State Librarian Johnson Brigham, of Des Moines. Papers on many subjects of interest were presented, among them a report on the Boone Mounds in Iowa by Curator Harlan, of the state historical department; a discussion of the human population of the Hawaiian Islands by Professor Charles C. Nutting, of the State University of Iowa, and a lecture by Mrs. A. M. Mosher, of Cambridge, Mass., entitled "The Story of the Isle of Man." Officers of the societies elected for the coming year are the following:

Iowa Society of the Archeological Institute:

President—E. K. Putnam, of Davenport, Iowa.

Secretary-Treasurer—Professor Charles H. Weller, of the State University of Iowa.

Iowa Anthropological Society:

President—E. K. Putnam, of Davenport, Iowa.

Secretary—J. H. Paarmann, of Davenport, Iowa.

Iowa Branch of the American Folk-lore Society:

President—Charles B. Wilson, of the State University of Iowa.

Secretary—E. K. Putnam, of Davenport, Iowa.

The regular monthly meeting of the Oregon State Academy of Sciences was held on October 16, the speakers being Dr. David Walker and Dr. L. J. Wolf, on "Arctic Explorations." Dr. Walker had been on two expeditions, the first with McClintock, and Dr. Wolf has been with Peary in 1905–6. Dr. Walker gave an account of early explorations and Dr. Wolf of his own experiences.

The United States Commissioner of Education, Dr. E. E. Brown, has announced that at the request of the Belgian government he has appointed an American committee to have charge of American interests at the third International Congress of Home Education to be held in Brussels in 1910. The membership of the American committee is Professor M. V. O'Shea, the University of Wisconsin, chairman; Professor W. C. Bagley, the University of Illinois, secretary; President Wm. L. Bryan, the University of Indiana; Mr. Wm. H. Allen, expert for the Sage Foundation, New York; Professor Irving Fisher, Yale University, chairman of the Committee of One Hundred; Judge Ben B. Lindsey, Denver; Superintendent Frank B. Cooper, Seattle; Mary E. Ahern, editor Public Libraries, Chicago; President E. R. Johnstone, New Jersey; President Lewis H. Jones, State Normal College, Michigan; Charlotte Perkins Gilman, editor, New York; Mrs. H. K. Schoff, president of the National Congress of Mothers, Philadelphia; Dean W. S. Sutton, University of Texas; Professor Henry Suzzalo, Columbia University; Bertha Payne Miller, the University of Chicago.

The International Congress of Mining, Metallurgy, Applied Mechanics and Practical Geology, held at Liége in 1905, resolved to accept the invitation of the Rhenish-Westphalian Mining Industry to hold the next congress in Rhenish-Westphalia, and it is now announced that the congress will be convened at Düsseldorf, the last week in June, 1910. It will be divided into the following sections: (1) Mining, (2) Metallurgy, (3) Applied Mechanics, (4) Practical Geology.

One of the most widely known of the rarer metals is tungsten. The production of this metal in the United States, however, is not large, as a little of it goes a long way for some of its most important uses. As by far the largest part of the tungsten produced is used in making tool steel, the demand for tungsten decreased greatly during the recent depression in the steel industry. In 1908 the domestic production of tungsten ore, reduced to an equivalent of ore carrying 60 per cent. of tungstic trioxide (WO_3), the ordinary commercial basis in the United States, was 671 short tons, valued at $229,955, as against 1,640 tons, valued at $890,048, in 1907. The statistics at present available from foreign countries show a similar decline. These figures are taken from a report by F. L. Hess, of the United States Geological Survey, published in an advance chapter from "Mineral

resources of the United States, calendar year 1908." Mr. Hess gives also details of the industry by states, notes on the occurrence and uses of tungsten, and a partial bibliography. Tungsten is of wide occurrence, but the individual deposits can hardly be said to be large. As a rule they are "pockety"—that is, they occur in lenticular masses or small shoots. Many of those at the surface are quickly and easily mined, but it may then take all the profits derived from the first ore body to locate another one. The tungsten minerals used as ores are hübnerite, a tungstate of manganese; wolframite, a tungstate of manganese and iron; ferberite, a tungstate of iron; and scheelite, a tungsten of calcium. They generally occur in veins cutting igneous rocks that contain much silica, such as granite and granodiorite. Some simple tests for identifying these minerals are described by Mr. Hess. The most important use of tungsten is as an alloy for tool steel, to which it imparts the property of holding temper at a much higher temperature than high-carbon steels. When lathe tools are made of tungsten steel the lathe may be speeded up until the chips leaving the tool are so hot that they turn blue. It is said that about five times as much work can be done by a lathe built for such speeds and work and fitted with tungsten-steel tools as can be done by the same lathe with carbon-steel tools. From 16 to 20 per cent. of tungsten is ordinarily used in lathe tools.

THE *Journal* of the American Medical Association states that the production of radium has been carried on in Johannistal to such a degree that at present there is available a quantity equivalent to 1 gm. (15 grains) of the pure substance. Several tons of the ore had to be worked up before an appreciable amount was obtained. It is intended now to put the available quantity on the market solely for scientific purposes and for charitable institutions. It will be sold in quantities of 1 mg. (about $\frac{1}{60}$ grain) of the 5 per cent. and the 10 per cent. salt. Bromid of radium has been chosen. The price of the 5 per cent. salt will be 1,080 crowns ($244) per portion ($\frac{1}{60}$ grain). The sale will take place in the radium institute just now in course of erection. A gift by an anonymous benefactor, who gave $100,000 for this purpose on the understanding that an equal sum should be provided by the state, enabled the Vienna University to obtain its radium research institute, the first in the world as regards equipment for investigators. The necessary appropriation having been voted, the building is now almost ready for use.

UNIVERSITY AND EDUCATIONAL NEWS

THE Chicago *Record-Herald* says: "Plans are in contemplation for giving the University of Chicago the finest physical laboratory in the United States, if not in the world. It is said that before all the plans are consummated the plant will have cost $1,000,000. All of the money is to be furnished by Martin Ryerson, president of the board of trustees of the university, who also was the donor of the present Ryerson laboratory at the university."

MR. SAMUEL MATHER, of Cleveland, and his children, have offered to erect for the College for Women of Western Reserve University, a building for class and lecture rooms, in memory of Mrs. Florence Stone Mather.

THE contract for the new chemistry building of Rutgers College has been awarded. The building will be located about 100 feet north of the engineering building which was completed last year. It will be built of brick with terra cotta trim and will conform architecturally to the engineering building. On the first floor will be a large lecture room seating about 200, and three class rooms, two seating about 50 students and one for 30 students. On the second floor will be the qualitative laboratory for 96 students, the quantitative laboratory for 64 students, a laboratory for work in electrochemistry and one for water analysis, professors' private offices and laboratories and a supply room. In the basement is the laboratory for the elementary work of freshman year which will accommodate 162 men, a laboratory for organic chemistry accommodating 24 men and the necessary heating and ventilating apparatus and a stock room.

THE annual meeting of the Association of American Universities will be held at the University of Wisconsin, January 4 and 5.

The University of St. Andrews will celebrate its five hundredth anniversary in September, 1911.

An exchange of professorships and students between universities and academies among all the American republics has been proposed by Secretary Knox. The suggestion has commended itself to the governing board of the International Bureau of American Republics, which has recommended that the proposed interchange shall figure in the program of the fourth Pan-American Congress to be held at Buenos Ayres next summer.

Mr. Walter George Smith, a Philadelphia lawyer, has resigned as a trustee of the University of Pennsylvania owing to the election of Dr. L. P. Lichtenberger as associate professor. He objected to Dr. Lichtenberger's views on divorce expressed by him at a meeting of the American Sociological Society in Atlantic City last year.

A new department of economic entomology has been organized in the College of Agriculture of the University of Wisconsin, and Mr. J. G. Sanders, of the U. S. Bureau of Entomology, has been appointed assistant professor in charge.

Professor H. G. Bell, of the Iowa State College, has been appointed professor of agronomy at the University of Maine.

Mr. Donald F. MacDonald, junior geologist, U. S. Geological Survey, is this winter in charge of the work in geology at Tulane University, New Orleans.

DISCUSSION AND CORRESPONDENCE

NATIONAL LEADERSHIP IN EDUCATION

The recent communications to Science of Mr. E. C. Moore and Mr. Theo. B. Comstock open a field that can not fail to be of interest to specialists in education, and of great importance to the country generally.

It is a good suggestion that the significance of the nation's work in education would be more adequately indicated by having a secretary of education than it ever could be by the office of commissioner of a bureau. If it should become a question of room in the President's cabinet, it might be entirely feasible to combine the functions of the Departments of War and Navy, or gradually to do away with them altogether. This would be especially appropriate, and in the line of just recognition, since no factor in our national life bids fair to do more to render these departments useless than education itself.

In our system of state independence as opposed to national unity, it is very difficult to say what could be done were the nation to assume definite control of general education. The already established departments of the executive branch of the national government vary in the degree of control of the field assigned to them. The existence of absolute control of the Postmaster General and the divided control of the Attorney General may be explained on the basis of the fact that one has organized a system for every one's convenience at small cost, while the other may threaten to encroach on certain "inalienable rights." The degree of control in either and all cases would also vary with the confidence inspired by the acts of the department. The mind of the nation shows signs of moving strongly to those factors in its life which are obviously affecting the general welfare. Here would lie the great hope of a Department of Education.

There are certain phases of the possible work of a Department of Education that seem to the writer to be of paramount importance. The west, the east, the north and the south have developed antagonisms through isolation and through variety of locality interests. In all these regions magnificent work in constructive ideas in the field of education is being done in spots. But except for the evanescent results of educational conferences and the poorly circulated printed page, there is nothing to help a great idea to stick. If in the state of New York an educational leader formulates the idea that the schools and colleges should train their students to be intellectually honest, there should be some central authority to recognize the far-reaching application that idea might have in curing us of the habit of indirection in official and business dealings, and in removing sectional prejudice.

If an able essay is written in the state of California showing that morality is a social obligation, there should be some means of bringing that idea to the notice of all the people. How could these things be done? For answer we may ask, how does the Department of Agriculture utilize the ideas of scientific men? If we establish experiment stations to discover means of conserving our material resources, why should we not establish experimental schools to test the usefulness of ideas directed toward the problem of social betterment?

Experimental schools under the supervision of a Department of Education would certainly be more productive of good from the very first than the occasional model school here and there through the country, for at least these three reasons: because the literature of all previous experiments in all countries would be at their immediate command, because the ideas of a nation's teachers would flow to it naturally, and because the successes and, equally important, the failures could always be matters of public knowledge.

We need better and more productive methods of school administration than those commonly employed. To this end national experimental schools could "try out" the various ideas along democratic lines that have come in our effort to free ourselves from the autocratic domination of one or a few strong or unprincipled men in control of systems of schools. Moreover, the classical, the scientific and the "practical" subjects must be analyzed as to the character of subject-matter, and experimented with for results. We have the dictum of the middle ages that the classical languages bring culture to the mind of the learner. Are there not other subjects which may yield the product of culture? Again, teachers of the natural sciences have long claimed a monopoly of material which on being studied trains students to think. We who are in the work must soon acknowledge that we have not proved our case. The explanation of failure may lie in the possibility of our not knowing how to handle our material. There can be no question that the natural sciences do present the opportunity for training to thinking. National experimental schools could take up the discoveries in methods made by isolated teachers of science, and make them productive of good to great numbers of the younger generation of citizens. The help to a nation of generally non-thinking people might be enormous.

National experimental schools covering all the work from kindergarten to college should be established in various parts of the country, for the benefit of the local schools and to the profit of the national schools themselves. For administrative as well as for pedagogical and social reasons, these schools should offer, for example in the secondary grade, *all* the subjects now taught in the classical or special high schools. Only through the organization of this, a cosmopolitan high school, could comparative results be obtained.

In this connection we should not fail to consider the expense of possibly a score of national schools. For that we could draw on the credit of the future to the extent of the cost of a few "dreadnoughts."

HENRY R. LINVILLE

JAMAICA, N. Y.

THE ASSOCIATION OF AMERICAN CHEMICAL RESEARCH LABORATORIES

TO THE EDITOR OF SCIENCE: Permit me, Sir, to correct an error in my letter printed in SCIENCE, issue of November 5, 1909. Among the laboratories which had, at the Clark University celebration meeting on September 16, joined the newly formed Association of American Chemical Research Laboratories, my letter mentioned that of Harvard University. This is due to a misunderstanding. Professor Richards, the chairman of the department, while "believing most heartily in the spirit and idea" of the association, had not explicitly pledged the Harvard laboratory to join it, and now the director of the laboratory, Professor Sanger, who has charge of all business matters, has definitely decided against adding the laboratory to the association list, in the belief that this would be contrary to "the terms under which our chemicals and apparatus are imported duty free."

I have thought it scarcely necessary to point out that the borrowing of supplies by educa-

tional institutions from one another is by no means an innovation, and its legality seems out of serious question. At any rate, the function of the new association is merely, through its secretary, to *inform* members as to where they can *borrow* (if they like) urgently needed research chemicals while waiting for them to arrive from Germany. I have received a number of letters prophesying usefulness for the undertaking.

M. A. Rosanoff,
Secretary

Clark University,
Worcester, Mass.,
November 20, 1909

THE CIVILIZATION OF BOHEMIA

To the Editor of Science: In the first paragraph of the address by Dr. M. Toch, on the first page of Science, of November 19, there occurs a certain generalization on the effects of illiteracy in several European countries. The writer says: "In many of the countries of Europe illiteracy is universal"—which, of course, is not correct itself. And this is followed further on, as in illustration of the effects of the illiteracy, by the sentence: "What have those countries like Roumania, Bulgaria, *Bohemia* (italics my own), Hungary, Russia and dozens of others, ever amounted to, and what are their commercial relations with the rest of the world, compared with Germany, France, England or the United States?" Now all I desire is to say a word regarding Bohemia, which is the land of my birth. The inclusion of that country in the above sentence is extremely unjustifiable, for as any statistics on that question, including the data of the U. S. Bureau of Immigration, will show, Bohemia leads all the countries of Europe, including the greater part of Germany, in the lowness of the percentage of the illiterate, these being practically reduced to the defectives. And as to whether that country ever amounted or now amounts to anything in the sciences, arts, industries, etc., it is sufficient to refer to history and to the commercial and tax statistics of the Austrian empire. In view of these facts the above statement must be characterized as a very loose one and it is regrettable that it found place in this esteemed journal.

Aleš Hrdlička

Washington, D. C.,
November 19, 1909

MARS AS THE ABODE OF LIFE

To the Editor of Science: On page 339 of Science I notice "2" has been printed for "r" in the denominator of the right side of the formula in the middle of the page. It reads correctly in my copy of the proof. The thing is evident as a misprint to any mathematician from the deductions—but it may as well be stated. Percival Lowell

QUOTATIONS

THE U. S. NAVAL OBSERVATORY

The President's recommendation concerning the Naval Observatory is eminently sound. He urges that the official head of that great astronomical establishment should be an eminent astronomer, and not a naval officer detailed for service for a shorter or longer term. This mode of filling the post of head of the observatory could not have survived so long as it has were it not for the entirely false notion conveyed in the name of the institution. As the President truly says, all the uses of the observatory specifically related to the needs of the navy might be subserved at a small fraction of the cost involved in the maintenance of the Naval Observatory. The part it really plays is that of a great national observatory, and its material equipment is of a character befitting such a part. The President calls it "the most magnificent and expensive astronomical establishment in the world." Alongside its important observational work is carried on the Nautical Almanac, in connection with which the labors of Simon Newcomb and of George W. Hill have made American mathematical astronomy illustrious the world over. The whole of this activity should, as a matter of course, be presided over by an astronomer of the first rank, under a permanent tenure, and not by a man who, in the nature of the case, must be comparatively an amateur, and who is likely to look upon the post as a pleasant berth

rather than as a great scientific responsibility. —New York *Evening Post.*

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

THE report of President Maclaurin, of the Institute of Technology, derives rather unusual interest as a fresh contemplation of old problems. These include the annual equation of making receipts equal expenditures, and the new questions of better salaries for instructors and a new location for the institute. Difficulty appears in keeping some of the best of the teaching force in the face of larger professional opportunities. The margin is frequently too great to be offset by the teacher's enthusiasm, and an appeal is made to the state to deal more generously with this institution. The present plant is criticized because of the noise, dirt and electrical disturbance to which it is subjected. The buildings are scattered and inconvenient and lack dignity. If a removal to some more favorable location is not soon made in ten years it will be inevitable, in the president's opinion, and the longer it is delayed the more difficult will it be to find a suitable situation. —The Boston *Evening Transcript.*

SCIENTIFIC BOOKS

Consciousness. By HENRY RUTGERS MARSHALL, M.A., L.H.D. New York, The Macmillan Co. 1909.

The intending reader will take this book in hand with a certain feeling of satisfaction due to first impressions. As a piece of bookmaking it is exceedingly well put together; and the analytic table of contents shows that it is the intention of the author to treat the various problems which he chooses to include under its title in an orderly and systematic way. The promise made by these first impressions is in the main well fulfilled. Moreover, the style of the book, although it is not always clear and is in spots positively obscure, is uniformly dignified and appropriate—recognizing obligations and differing with self-restraint and sobriety, and without resort to those kaleidoscopic turns and twists of argument and tricks of rhetoric which have cost the would-be science of psychology so dearly in this country.

The author announces in the preface (p. vii) such a "restatement of psychological doctrine" as shall "bring all related psychic facts into harmony with the theory" which he has defended in some of his previous writings. With the expert student of these facts, such a statement as this is certain to create grave misgivings. For at this somewhat late day in the history of psychology, as of any other of the so-called sciences, the temptations connected with the attempt at restatement of all its facts are almost irresistible. Of these temptations the following two are chief: first, the temptation to think that one is saying something new, because one is telling the same old story in a different and not infrequently a more uncouth language; and second, the temptation to force the facts into harmony with the new theory, under cover of a difference in the language used to describe them. Let us not forget, then, that in the development of any science, *restatement* can not create any new facts or justify any new interpretation of facts already known. At best, it is only a matter of convenience in the method of arrangement and exposition. Of late in psychology, in our judgment, most similar attempts have hindered quite as much as they have helped the discovery and the elucidation of its more fundamental truths.

Mr. Marshall divides the treatment of his theme into three separate books. Of these, Book I. treats of Consciousness in General; Book II., of The General Nature of Human Presentations, and Book III., of The Self. Each of these books is again divided into parts, divisions, subdivisions, chapters and numerous short paragraphs—giving an appearance to the whole not unlike that of Spinoza's "Ethica." Thus the form of presentation is made to accord quite strictly with the plan which, as we have seen, proposes to restate all the psychic facts in terms of a new theory that shall embrace and explain them all. At this point, the devoted psychologist can scarcely refrain from the prayer: Would to heaven that the attempt might be successful!

Before examining any of the particular problems dealt with by the author, it is de-

sirable that we should form some preliminary conception of the general theory which is to prove a solvent for them all. This theory is by no means difficult to state. It is that all the phenomena of consciousness (the inclusive title which the book bears) may be explained as due to "presentations," and groups and smaller and larger systems of presentations, and of their present and past reactions on one another. In this principle, and indeed in not a few of its applications, Mr. Marshall's theory closely resembles, and is a sort of *replica* of, Volkmann von Volkmar, whose masterly treatise (one of the most notable works on psychology of the past century), in spite of all the ado made by writers on pedagogy over Herbart (and Volkmann is the finished product of Herbartianism) is scarcely known at all in this country. Volkmann, too, accounted for all the psychic facts in terms of the combinations of *Vorstellungen,* both in the field of consciousness and "below the threshold." Volkmann, too, made use of elaborate and abstruse algebraic formulas to set forth the forms and laws of the actions and reactions of the *Vorstellungen*—a device which Mr. Marshall uses sparingly (see, however, pp. 72 ff.), but helps out with more strictly architectural material in the shape of geometrical diagrams.

Thus far considered, the theory of the "systemic" nature of human consciousness, although it involves not a few highly conjectural elements, is essentially a psychological affair. For presentations, like *Vorstellungen,* are psychic facts, so far as they have any existence at all. And this is to say that our theory explains some psychic facts by other psychic facts. But an equally important side, or half, of the complete theory of Mr. Marshall's book is what the author calls "neurgic." These neururgic facts, which are to constitute this other half of the complete theory, are, of course, happenings in the human nervous system. As facts, they can be known only by prolonged and expert and purely "objective" research; and the sciences that discover and explain them are physiological chemistry, histology, physiology, etc. Now, thirty-five or forty years of devoted, although somewhat intermittent, study of the subject has convinced the writer of this critical review that all the attempts hitherto made to establish a scientific theory, at once precise and inclusive, of the relations between the "neururgic" facts and "all the psychic facts" prove on examination premature and even delusive. But in Chapter I., which treats of Noetic Correspondences, Mr. Marshall adopts a theory of complete parallelism between the two classes of facts. Every fact of sentience, even the unknown or the essentially unknowable, corresponds to some fact of a definite neururgic character. Nowhere, however, are we told what is the effective nature of this alleged correspondence.

In order to orientate ourselves the better for understanding the positions taken in the later chapters, let us pause a moment in the point of view held in this first chapter. From this point we behold two parallel lines drawn, which are to include within them the entire domain of the science of psychic facts. One of these lines—the psychic—consists in part of undoubted psychic phenomena, which are established in the only way in which such initial facts can be established; and this is by the awareness of the subject who experiences them. Such facts are, however, only spots, more or less detached from one another, in the total line. Between and surrounding them, are parts of the line which consist of psychic facts of which no one is ever directly aware, but which have a certain claim to reality because of the service they render as explanatory of undoubted facts; but the greater part of this line consists of purely conjectural occurrences, to which, although they are never in consciousness at all, terms are given the applicability of which can be verified or disproved only by self-consciousness. Parallel with this line is another—the so-called "neurgic"—the facts of which are of a quite different order, and which, as facts, are scarcely touched upon by our author; but the rest of this line—*i. e.,* the most of it—is made up of unverified and unverifiable conjectures. This becomes a case, then, where not only is the general theory conjectural (and yet of the

nature of a permissible hypothesis), but where the alleged facts are largely conjectured in support of the theory; and this along both the parallel lines—facts of sentience and facts called neuroses.

How this general theory works in its attempts to deal with definite psychological problems we shall now test in a number of selected particulars. We hasten to say that where Mr. Marshall approaches any psychological problem without emphasizing his general theory for explaining "all psychic facts" by correspondences between largely conjectural facts of sentience and almost wholly conjectural neururgic facts, he is much at his best. In such cases he shows the candor, learning and depth and breadth of insight, from the more general exercise of which an improvement of psychological science, now so severely threatened with disintegration and degradation, might reasonably be expected.

Mr. Marshall makes clearly and well the distinction between consciousness as sentience, the universal characteristic of all psychical life, and consciousness as the "awareness" of an object, whether percept of thing or consciousness of self. But, in our judgment, he weakens the value and mistakes the significance of this distinction when he speaks of "sub-attentive consciousness," and fails to see that some at least faint share in the distribution of attention is necessary in order that any particular part of the field of sentience may lay claim to being part of this field at all. Nor is this a point of no importance for our general psychological theory. For since all the earlier and simpler conative manifestations of mental life are connected with attention, the failure to recognize them on the lowest levels of this life renders the theory lacking in the prime requisite of all modern science; we will call it "*dynamic* quality." It is not surprising, then, that our author, having only presentations and systems of presentations to deal with, so frequently overlooks or minimizes the "energetics," or active aspect of—not the presentations, but of the being whose are the presentations.

Other particulars in Book I. with which we find ourselves in agreement are the "systemic" view of consciousness, as against all attempts to regard it as a "blooming confusion" or to ridicule the efforts to analyze it into elements or factors, if only these latter words are understood in accordance with the unity of consciousness; with what is said (p. 94 f.) about the unsatisfactory assumptions connected with the customary theory of the "association of ideas"; with the doctrine that pleasure and pain are not sensations, but "general qualities of all presentations"; and with the view that other than human consciousness is of necessity described and explained in terms of our consciousness.

We also note with peculiar satisfaction Mr. Marshall's discussion and rejection of the theory of Lange and James concerning the muscular and peripheral origin of the emotions (the central determining conditions of which we have ourselves discussed at great length, elsewhere); and as well, the unwarrantable and almost unintelligible contention of Stumpf and James that some special quality or specific element, to be called "extensity," belongs to the material content of every sensation. In a word, this first book, being, after the theory of parallelism is once stated, little burdened with that theory, is perhaps of all three books the most satisfactory.

Book II., which, as we have already seen, treats of The General Nature of Human Presentation, in its doctrine of their intensity and complexity, presents no features worthy of special attention. But the case is not the same with Mr. Marshall's views as to what he calls the "realness" of certain presentations. This qualification he seems to resolve into the one element of persistence or stability (pp. 221 ff.). It might properly be objected that many of the impressions of the *real,* both in ourselves and in outside objects, are among the most sudden, sharp and unstable of all our presentations. But the entire following discussion shows how inadequate is the basis laid in this way for the subtle, exceedingly complex and eminently intellectual and profoundly metaphysical, human conception which answers to the word "reality." Nor does the

somewhat dubious and partial acceptance of Professor James's theory of the will to believe as the creator of reality much help out the matter. More light would have been thrown on this obscure subject if the author had thoroughly worked out the suggestion received in a private letter from Professor Gildersleeve: "To the Greek the world was first 'Wille'; then 'Vorstellung.' The consciousness of the not-me comes from the putting forth of will." This most important truth, so early recognized by Greek thought, we have ourselves elaborated at great length in various writings, and as it appears both from the modern psychological and from the metaphysical points of view. It is worth mention in this connection, that the same view is extensively adopted by physicists who are interested in the psychological and metaphysical aspects of their particular science.

The physiological theory of the pleasure-pains, which resolves the fundamental difference in character and all the differences in the intensities of the two series, into the efficiency or inefficiency of the neural elements to respond to stimuli, like all similar theories, offers an explanation of only *some* of the phenomena. The discussion of the time concept, while it assumes the correct position that its entire basis in experience is given in the fact, that presentations actually occur in succession, is obscured by the use of the misleading term, the "specious present"—misleading, because the so-called *specious* present is the only *real* present; it is the actual "now" comprised within the grasp of consciousness. But the present conceived of as a mathematical point is not, and never can be, actualized. A similar misconception has been the source of a lot of silly puzzles, such as that of the inability of Achilles to overtake the tortoise, of the arrow to fly, etc, which have tormented the brains of men, to no good purpose, through centuries of misspent time. How often does the student of psychology, who wishes to arrive somewhere, wish also that such phrases as "specious present," "stream of consciousness," and many similar phrases, had never been born!

It is in his treatment of the Qualities of Relation (Chapter XIII.) that the author begins to show the more serious results of his general theory. So far as the relations of so-called presentations can be considered objectively, or better passively, no serious objection to the treatment is to be urged. On the contrary, it is, in several respects, excellent; but there is nowhere any clear recognition of the fundamental truth that relations between presentations, objectively considered, can come into existence only as the result of "discriminating consciousness," or the mind's relating activity. While, then, attention is again recognized as "a very general aspect of consciousness" (p. 314) and the statement that the distinction between involuntary and voluntary attention is largely, oftentimes, a matter of degrees is quite true; and while it must be admitted that attention is not all of will, although it is "the very essence of connation"; the general theory of psychic facts as due to correspondences between neururgic facts and facts of sentience, seems to us utterly to break down when it faces the experiences and the developments of man's intellectual life. *Thinking and the cognitive judgment can never be explained—and, indeed, the facts can not even be stated—in terms of either neurgics or the mechanism of presentations.*

But the inadequacy of the theory is more conspicuous when the attempt is made to explain in its terms the Object-Subject Relation (Chapter XV.). We are here told that it is "the correlation of realness (or stability) and manifoldness" of the presentations which gives us the object-subject relation (p. 345). But Mr. Marshall, who is usually so clear in style, becomes increasingly unclear, as he attempts to show us how a mere correlation in presentations can beget a self-consciously active "empirical ego." Nor does the already much over-worked function of "a will to believe" by any means serve to supply all the missing links between this machine-controlled field of conscious and unconscious presentations and a "real, live man." The obvious reason is that unless a will, that counts for something, is recognized at the start, it can

not be introduced afterward as the gift of either the nervous system or of the system of presentations.

No wonder, then, that when, in Book III., the same general theory is applied to the profound and difficult problems offered by such a conception as that of the human self, we come almost immediately upon the following statement (p. 475 and note): "We are bound thus to assume that all animals which experience a stream of presentations must have selves not fundamentally dissimilar from human selves." We refuse to recognize any such obligation. And this because we do not find that any semblance of a real self, human or otherwise, can be constructed by any system of presentations, no matter how manifold or skilfully compounded.

The book closes with discussions of the problems of moral responsibility and immortality. This seems to us the most interesting and suggestive part of the entire treatise. But the general theory is carried, in the attempt at a solution of these problems, to its consistent logical result. What appears to the self as free will, even when it culminates in choice, is but the triumph of the stronger over the weaker group of presentations. Character is the general fact that such, rather than other presentations, are accustomed to triumph in the conflict for realization of presentations in the successive fields of consciousness; its basis is laid in an inherited neururgic system. The empirical ego and the self, being a series of presentation compounds, can not, of course, reasonably maintain even the hope of an immortal life. In these important particulars, Mr. Marshall's views resemble more closely the Buddhistic doctrine of *Kharma* than those of western writers generally, when uninfluenced by oriental philosophy.

GEORGE TRUMBULL LADD

SOME NEW CHEMICAL BOOKS

An Elementary Treatise on Qualitative Chemical Analysis. By J. F. SELLERS, Professor of Chemistry, Mercer University, Georgia. Revised edition. Boston, Ginn & Co.

The revised edition of Professor Sellers's manual is a very good book. The author bases analytic reactions on the dissociation theory, and introduces a number of questions, answers and examples, showing the student in a very helpful way just how this theory explains so many phenomena met in analysis.

A Manual of Qualitative Chemical Analysis. By J. F. MCGREGORY, Professor of Chemistry and Mineralogy in Colgate University. Revised edition. Boston, Ginn & Co.

The revised edition of Professor McGregory's manual is also a good, thorough, well-written book. The author does not think it advisable to introduce the dissociation theory at this stage, and prefers old well-tried methods of separation. Many teachers agree with him.

These two manuals—each excellent—are examples of radically different methods of teaching analysis. A few years ago an occasional book appeared written more or less (generally less) on physical-chemical lines. Now, as a matter of fact the reverse is true. Within the last few years some excellent methods of separation have been devised by Noyes and his co-workers and by others. The conservative manual, rejecting new theories and clinging to the old methods of analysis, is slowly disappearing. The same tendency is even more noticeable in elementary text-books of chemistry; the next three books we have under consideration are text-books, and while each is markedly different from the others all have the common factor of explaining the action of acids on bases and many other phenomena, by the dissociation theory.

Elementary Modern Chemistry. By WILHELM OSTWALD, Emeritus Professor of Chemistry in the University of Leipzig, and HARRY W. MORSE, Instructor in Physics in Harvard University. Boston, Ginn & Co.

Ostwald's little book is probably intended for schools; he touches only the leading facts in chemistry, omitting much that others would retain, while introducing many physical experiments which others would omit. Writers of quite elementary books generally reduce theory to a minimum; Ostwald makes the proportion of theory much greater in this

little book than in his "Grundlinien"; but Ostwald has the power of wording theory so that an intelligent boy not only can understand it, but will be fascinated by it. Hence this is an exceptionally good book for a school, and an ideal foundation for a modern college course. The experiments are simple and require little apparatus. The book is illustrated by excellent diagrams of apparatus and by portraits of leading chemists.

General Inorganic Chemistry. By CHARLES BASKERVILLE, Ph.D., Professor of Chemistry in the College of the City of New York. Boston, D. C. Heath & Co. Pp. 357.

This book differs from most text-books in three important particulars: it is not illustrated, it has scarcely any experiments, its arrangement is quite different from that usually adopted. As to its arrangement, after consideration of hydrogen, oxygen, water, the halogens, the alkali metals, nitrogen and carbon, comes the periodic law; then the elements are considered as such in the order of their grouping in the system; next come the hydrogen compounds of the elements, followed by the halides; chapters on molecular weights and dissociation come next, followed by chapters on the oxides, sulphides, hydroxides and hydrosulphides of the first three groups and part of those of group IV.; then come the carbonates of all the groups; then oxides of silicon, followed by the remaining oxides and sulphides of group IV. Enough of the contents has been given to show the plan of the work. Some teachers may prefer this sequence to that commonly followed. While the book is not large, it is well written, is distinctly original and replete with information.

A Course in Inorganic Chemistry for Colleges. By LYMAN C. NEWELL, Ph.D., Professor of Chemistry, Boston University. Boston, D. C. Heath & Co. 1909. Pp. 594.

This book is intended for the first year in college chemistry. It is well written, thorough, longer than most books of the same grade, but contains nothing too advanced; a part of the excess text is given to theory; electrolytic dissociation, reversible reactions, equilibrium, catalysis, vapor pressure, electrolysis and the behavior of dissolved substances are adequately treated. Still the book is mainly descriptive; descriptions of technical methods and the technical and practical uses of chemical compounds are allotted much more space than is usual. This is good, for a student should familiarize himself with these matters and the first year is the best time to study the outlines of applied chemistry.

Professor Newell's book is illustrated by excellent diagrams and by portraits of great chemists; it ranks among the best college text-books for the first year.

The Calculations of General Chemistry, with Definitions, Explanations and Problems. By WILLIAM J. HALE, Ph.D., Assistant Professor of Chemistry in the University of Michigan. New York, D. Van Nostrand Co. 1909.

The author intends this book on chemical arithmetic to accompany the first year's laboratory work in general chemistry; he says in the preface:

> In the manner of presentation a somewhat different plan has been followed from that usually found in books of this nature. This consists in a gradual introduction of each new condition properly falling under the consideration of some one subject, and the final development of the subject in its entirety from all the conditions thus considered.

The book is doubtless the best yet offered in this field, and should be carefully examined by college teachers.

The Romance of Modern Chemistry. A description in non-technical language of the diverse and wonderful ways in which Chemical Forces are at Work, and of their manifold application in Modern Life. By JAMES C. PHILIP, D.Sc., Ph.D., Assistant Professor of Chemistry, South Kensington College of Technology. London, Seeley & Co.; Philadelphia, J. B. Lippincott Co. 1909.

The cover of this work is multicolored and lurid; the headings in the table of contents suggest those in the daily papers; as—"How Artificial Alizarin has Ousted the Natural Dye from the Market—Natural Indigo Badly Hit—Synthetic *versus* Natural Camphor."

Cover and headings lead one to expect an unbalanced sensational book; this is not the case. The author seems to feel that to make his book interesting to the general reader he must occasionally try to be flippant and sprightly by using slangy colloquialisms. He may be assured that this is not necessary; he has an interesting story to tell and he tells it in a vivid, interesting way. The book is so good that it is a pity it should be marred by these blemishes, and if the author would cut them out in his next edition his book and its readers would be gainers.

The title-page describes the plan of the book; it suggests Lassar-Cohn's famous "Chemistry in Daily Life," which is written on similar lines, but each contains much that the other does not. It is well illustrated and should be welcome to libraries and to the general reader.

EDWARD RENOUF

Exercises in Physical Chemistry. By W. A. ROTH, a. o. Professor of Physical Chemistry in Greifswald; translated by A. T. CAMERON. New York, D. Van Nostrand Co. $2.00.

This book, embodying, as the author states, the practical course used in Professor Nernst's laboratories, needs no words of praise. Well-chosen experiments are described with full details and due emphasis is laid on consideration of sources of error, methods of calculation, theory of phenomena involved and all that a beginner needs to be told in order to gain the real educational value of the work.

A Text-book of Physical Chemistry; Theory and Practise. By ARTHUR W. EWELL, Assistant Professor of Physics, Worcester Polytechnic Institute. Philadelphia, P. Blakiston's Son & Co. $2.25.

If this book has a fault, it suffers from "the last infirmity of noble minds," extravagant ambition. Within the scope of 360 pages the author attempts to give "a laboratory manual, a text-book" and a "convenient book of reference." Considering the nature of his task, the author's success is remarkable, though it suggests strongly the breathless haste of the inexperienced tourist trying to "do" all Europe in three months. As a laboratory manual the directions are hardly full enough; a text-book, in the sense of a book from which the average student could, if necessary, educate himself, it certainly is not; as a work of reference it should prove useful to general students who can not afford to buy larger works. But rather than any of these it resembles those sheets of "lecture notes" which many teachers give their students for purposes of review and as such it is unusually excellent. Statements of fact are almost uniformly correct and theoretical demonstrations, though concise, are adequate, and do not, as in so many similar works, shirk the use of elementary calculus. The author evidently has a thorough grasp of his subject, and, as is shown by a judicious selection of references, a first-hand acquaintance with the literature. But some experience of college and university students causes the reviewer to wonder whether one man in a score could assimilate without mental indigestion, all the contents of this book in less than three or four years of undergraduate study. Expanded to three times the size and properly peptonized it would make one of the best text-books in the English language for post-graduate students specializing in physical chemistry.

B. B. TURNER

The History of the Teaching of Elementary Geometry, with Reference to Present-day Problems. Submitted in partial fulfilment of the requirements for the degree of doctor of philosophy in the Faculty of Philosophy, Columbia University. By ALVA WALKER STAMPER. Pp. x + 163. (Preface dated 1906.)

Comparatively few scholars in the United States are selecting the history of their chosen science as a subject of research. For that reason it is an unusual pleasure to welcome the author of this monograph into the ranks of historians of science. Much has been published on the history of geometry, but the book under review is the first devoted to the history of the *teaching* of elementary geometry. Naturally, one could not trace the history of the teaching of geometry without making frequent references to the history of

the science itself. Especially is this true of the Greek period, in which all data about teaching are closely interwoven with statements relating to geometrical research. Dr. Stamper devotes the first three chapters to the Greeks, Romans and Orientals, one chapter to the Middle Ages, one long chapter to the seventeenth, eighteenth and nineteenth centuries, and two chapters to present-day teaching. The last three chapters contain much that is original with the author. Teachers of geometry will find them suggestive and valuable. Texts have been examined to which no references are usually found in histories. Doubtless it is more difficult to secure data on the teaching than on the progress of a science. In illustration of the difficulty of securing data on teaching we refer to the author's acknowledged inability to fix the time when Euclid began to be used as a text-book in English secondary schools within a closer range than three quarters of a century. Dr. Stamper claims that in England there were no texts on the practical side of geometry, nor any combining the practical with the logical, such as prevailed on the continent up to about the middle of the seventeenth century. We doubt the accuracy of this statement. The present writer has before him books explaining the use of the slide rule by William Oughtred (1660, 1st ed., 1632), Seth Partridge (1662), Hunt (1697), Everard (1705), Leadbetter (1755), which may certainly be classed among works of practical geometry. These books offer fine examples of the correlation of geometry with arithmetic and trigonometry. The title-page of Coggeshall's book refers to the "Use of Scamozzi's Lines, for finding the Lengths and Angles of Hips, Rafters, etc., at any Pitch, in Square, Beveling or Tapering Frames," explained by John Ham, mentioned later in the text as "Master of the Mathematical School at the Chapel in Hatton-Garden, Holborn." The book contains also a regular "compendium of practical geometry." Nor must we forget John Ward's "Young Mathematician's Guide" (1707) where, out of a total of 427 pages, 64 are given to geometry, the subject being treated in a manner quite remote from Euclid's. In 1771 this text reached its twelfth edition. In the preface we read:

> This treatise hath proved a very helpful Guide to near five thousand persons; and perhaps most of them such as would never have looked into mathematicks at all but for it. . . . And not only so, but it hath been very well received amongst the Learned, and (I have often been told) so well approved on at the Universities, in England, Scotland, and Ireland, that it is ordered to be publickly read to their pupils.

In this country Ward's text was used at Harvard College as early as 1737, and as late as 1787 at Yale and Dartmouth.

While the author worked industriously, there are some gaps in his history. For instance, no reference is made to the texts of Basedow and his efforts at reform, nor to the remarkable works of Louis Bertrand. Nor has he used all the available secondary sources of information, such as J. H. Graf's history of mathematics in Bern and L. Isely's history of mathematics in the French part of Switzerland.

The book lacks an alphabetical index, but has a full table of contents and a list of the original and secondary sources used in its preparation. This list will be welcomed by all who may desire to undertake research work on the teaching and history of elementary geometry. FLORIAN CAJORI

A Treatise on Zoology. Edited by Sir E. RAY LANKESTER. Part I., Introduction and Protozoa. First Fascicle, by S. J. HICKSON, J. J. LISTER, F. W. GAMBLE, A. WILLEY, H. M. WOODCOCK, E. RAY LANKESTER and the late W. F. R. WELDON. Pp. ix–xxii + 296; 151 figs. London, A. & C. Black. 1909.

The present volume, together with the previously published second fascicle dealing with Foraminifera, Sporozoa and Infusoria, completes the account of Protozoa in Lankester's well-known "Treatise on Zoology." The Proteomyxa and Lobosa are described by S. J. Hickson; the Heliozoa by the late W. F. R. Weldon and S. J. Hickson; the Mycetozoa by J. J. Lister; the Radiolaria by F. W.

Gamble; the Mastigophora by A. Willey and S. J. Hickson; the Hæmoflagellates by H. M. Woodcock, while descriptions of Chlamydomyxa and Labyrinthula written by J. J. Lister, form an appendix.

There is little to be said on the whole in regard to the descriptions of the majority of the articles. The section on Hæmoflagellates contains many important facts regarding hosts and parasites, otherwise it differs little from Woodcock's original article in the *Q. J. M. S.*, 1906. It is remarkable, however, that Spirochæta and Treponema are not mentioned in the account of the Mastigophora and that these most widely studied of all protozoan parasites should be passed by with only a short statement in an appendix to the Hæmoflagellates. All of the articles are fairly clear and well-written expositions of the structures and modes of life of the several types of Protozoa, but with the exception of the sections on Mycetozoa and Radiolaria there is little that is new or above the average of an ordinary text-book, while there are few references to literature later than 1906. With the Mycetozoa and the Radiolaria, however, there is no savor of mediocrity. Here the descriptions of structures and life histories are written with reference to the problems in general biology with which the protozoa have the most to do, and with a philosophical breadth of view as refreshing as it is novel.

While the book makes no pretense of arranging the various groups of Protozoa in any way that might be construed as showing phylogenetic relationships of the unicellular animals, it does seem peculiar and unnecessary to separate Heliozoa completely from Radiolaria and insert a section on Mycetozoa between them. As long as the organs of locomotion of Protozoa are accepted as indicating the natural limits of a group, consistency at least should be exercised to keep the undoubted close relations of these two groups before the eyes of the student. There is some danger, too, of the latter becoming so tangled up in a maze of unfamiliar terms that he might well wish to get away from the subject as soon as possible and leave the Protozoa to pedants. He finds that "koniokaryote" protoplasm superseded the condition of "plasson"; that the well-known and well-understood term "cytoplasm" must be replaced by the unfamiliar word "periplasm," and his brain whirls with the confusion of "gubernaculum," "tractellum," "pulsellum," while his ideas of the fixity of biological conceptions get sadly twisted in trying to discover why nature ever made the mistake of allowing a "tractellum" to act as a "pulsellum," or a zoologist to go backwards twenty-five years and classify *Volvox* as a protozoon!

As with all the volumes of this treatise the type, page and illustrations are excellent, the latter being well drawn, clearly reproduced, and many of them unusual as text-book figures. The paper is altogether too thick and clumsy however, making a heavy and poorly bound volume, which will never stand the wear of ordinary use.

G. N. C.

SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Biological Chemistry, VI., No. 6, issued November 12, 1909, contains the following: "The Purines and Purine Metabolism of the Human Fetus and Placenta," by H. Gideon Wells and Harry J. Corper. A study showing the independent development of the various purine enzymes during the growth of the fetus and indicating active metabolism in the placenta. "Soluble Chitin from *Limulus polyphemus* and its Peculiar Osmotic Behavior," by C. L. Alsberg and C. A. Hedblom. Prolonged treatment of *Limulus* chitin with HCl produces soluble chitin which has the peculiar power of dialyzing and of carrying the water in which it is dissolved through the membrane. "Some Observations on the Study of the Intestinal Bacteria," by A. I. Kendall. An outline of general procedures applicable to the determination of the more important types of bacterial activity in the intestinal tract. "A Study of the Chemistry of Bacterial Cellular Proteins," by Sybil May Wheeler. A comprehensive study of bacterial proteins from various sources, their properties, the nature and amounts of their cleavage products together with accounts of efforts to

isolate and identify the toxic elements in them.

SPECIAL ARTICLES

THE GEOLOGICAL AND GEOGRAPHICAL DISTRIBUTION OF SOME PLEISTOCENE MAMMALS

Some months ago Professor Henry F. Osborn, of the American Museum of Natural History, published[1] an important paper entitled "Cenozoic Mammal Horizons of Western North America." Having had occasion recently to consider some phases of the Pleistocene I have examined with interest the part of Professor Osborn's paper devoted to this period.

Professor Osborn has been giving attention to Tertiary history and correlation for many years. In 1900[2] he published his "Correlation between Tertiary Mammal Horizons of Europe and America," in which he devoted eleven pages to a consideration of the Pleistocene. In connection with this he issued a "Third Trial Sheet," in the preparation of which he had the assistance of several European geologists and paleontologists. The paper and the trial sheet dealt more especially with European history. The paper of 1909, put forth after nine years' further investigation on the part of Professor Osborn, during which time numerous other paleontologists and geologists had occupied themselves with Pleistocene studies, presents more fully the American side of the problems.

In Professor Osborn's treatise of 1900 he and his collaborators recognized fully the work that had been done by geologists in their determination of the existence, in Europe, of more than one sheet of glacial accumulations and one or more interglacial deposits. In the communication of 1909, on the contrary, Professor Osborn makes no mention of the great advances that have been made within recent years in the knowledge of the Glacial epoch in North America, resulting in the discovery of four or five distinct glacial sheets and a corresponding number of interglacial deposits of soils, peat beds, gravels and sands, with their organic contents. His bibliography of the Pleistocene (pp. 17, 18) contains no references to such authors as Bain, Calvin, Chamberlin, Dawson, Leverett, Lewis, Salisbury, Tyrrell and others whose works have been of the highest value in the solution of many problems connected with Pleistocene history. And it may be affirmed with confidence that without giving due consideration to glacial geology no correct solution of the paleontology of the Pleistocene is possible.

It appears to have been Professor Osborn's intention to divide the Pleistocene into the Lower, or Preglacial; the Middle, or Glacial, and the Upper, or Postglacial; although he does not mention the last division. We need not here discuss the propriety of recognizing a preglacial stage of a period that has little or nothing to distinguish it from the Pliocene, except the presence of glaciers. On page 87 of Bulletin 361 is a table showing the approximate times of appearance and disappearance of certain important genera of mammals. It is an unfavorable comment on our knowledge of the Pleistocene, when all that can be said of six important genera is that they disappeared at some time during the Glacial period. It is my belief that the history of some of the interesting animals concerned can be determined somewhat more accurately. A beginning will be made with *Equus*, the horses, a genus which Osborn says disappeared from North America during the "upper mid-Pleistocene," a time which unfortunately he does not limit either downward or upward.

If now we indicate on a map all of the apparently authentic finds of fossil horses in the United States east of the great plains, we learn that, starting in New Jersey, one series of localities arranges itself along the Atlantic and the Gulf coasts, while the other, with a few important exceptions, follows an irregular line through Pennsylvania, Ohio, Indiana, Kentucky, Illinois, Missouri, Iowa and South Dakota. A comparison with a map showing the glaciated region of the country indicates that the localities of the last series (barring the few exceptions) are situated close to the southern border of the drift-covered area.

The earliest discovery of fossil horse re-

[1] Bull. U. S. Geol. Surv., 361, pp. 1–90.

[2] *Ann. N. Y. Acad. Sci.*, XIII., pp. 1–64.

mains was made near the Neversink Hills in New Jersey, a considerable distance south of the drift-covered region. Other remains have been found near Philadelphia, likewise south of the drift. Teeth and bones of two species of horses were discovered in Port Kennedy cave, but this too lies south of the glaciated tract. Two teeth of an extinct horse were found in the banks of the Susquehanna River, at Pittston, Pennsylvania, some twenty miles north of the terminal moraine; but Leverett shows by his map[3] that just south of Pittston there is a much older drift sheet. The teeth in question may therefore have been buried in this layer or even below it, in preglacial deposits which may continue north as far as Pittston.

Further west, remains of horses have been found at Cincinnati and at Big Bone Lick. These localities are within the border of the Illinoian drift sheet and possibly the remains are in an interglacial deposit below the drift, inasmuch as at Cincinnati they were obtained several feet below the surface of the drift. Scanty remains of a horse have been discovered near Evansville, Ind.; but this is outside of the glaciated area. The same is to be said regarding two localities in Missouri.

Many years ago Dr. Skilton called attention to some horse teeth that had been found near Troy, N. Y., but there is nothing in the case to make us suppose that they were anything else than the teeth of the domestic horse. Two teeth of a fœtal or new-born horse have been reported by Leidy from Hartmann's cave, near Stroudsburg, Pa. This cave is situated eight or nine miles north of the glacial moraine. Inasmuch as the cave had long been open, so that boys had been accustomed to explore it, the colt teeth may have been rather recently introduced by some carnivorous animal. A more reliable discovery was made many years ago in a bog near the line between Bond and Fayette counties, Ill. From this place Worthen sent to Leidy the maxillary bone, with the four premolars, of a horse which Leidy identified as *Equus complicatus*. Through the kindness of Dr. A. R. Crook, curator of the state museum, at Springfield, I have had the opportunity of examining the specimen and have had the benefit of the expert knowledge of Mr. Gidley. Neither the bone nor the teeth are to any considerable extent mineralized. The teeth have the enamel somewhat more complicated than it is in any known specimen of the domestic horse, but it does not have the thickness indicated in Dr. Leidy's figure of the specimen. The teeth have almost exactly the structure shown in a thoroughly fossilized tooth found at Big Bone Lick and sent by Dr. Crook. The specimen may therefore be regarded as belonging to an extinct horse, probably *E. complicatus*. All that part of Illinois is covered over by the Illinoian drift sheet and since the tooth lay on this drift it must be younger than the Illinoian. It may belong to the Sangamon interglacial deposit. If so, the genus continued to about the middle of the Glacial epoch.

Dr. W J McGee[4] mentioned the finding of a tooth of *Equus complicatus* in northeastern Iowa. In reply to my inquiry Dr. McGee kindly informs me that the tooth was found near Sandspring, Delaware County, Ia., lying on a knoll of Niagara limestone. According to the geological map of this county, the immediate region is covered with Iowan drift, which overlies Kansan drift, but with intervening interglacial gravels and sand. Little of these sheets, except some coarse materials, was left on the wind-swept knoll. In case the tooth had been originally buried in or above the Iowan drift it would hardly have endured the weathering incident to being lowered to the limestone.

Mr. McAdams[5] reported the discovery of a tooth of a horse at the bottom of a well that was being dug in Greene County, Ill. The exact locality was not given. All that region is covered by Illinoian drift. The tooth may have been buried in an interglacial deposit below this. The same writer reported another tooth from Alton, Ill., but no details were given.

[3] Mon. U. S. Geol. Surv., XLI., Pl. II.

[4] Eleventh Ann. Report U. S. Geol. Surv., p. 495.

[5] *Trans. St. Louis Acad.*, IV., p. lxxx.

A remarkable discovery of vertebrate fossils in localities covered over by glacial drift has recently been detailed by Professor Samuel Calvin.[6] Two species of horses, five proboscidians, a camel, mylodon, megalonyx and other extinct mammals are described. The localities are not far from the Missouri River. These remains were buried in the soils belonging to the Aftonian interglacial stage, which preceded the Kansan ice sheet. Therefore, they come to us from near the beginning of the Glacial epoch. It is a fact which may be noted here that, although a large part of Iowa and a part of Kansas are covered by the Kansan drift sheet, which offers facilities for observation and which has been studied closely by geologists for many years, no bones or teeth of fossil horses have yet, so far as I can discover, been found on its surface. Nor have any been found on the surface of the Iowan drift or in it. Nor are there any reliable evidences that remains of horses have been found in those regions that are occupied by glacial deposits belonging to the early and the late Wisconsin stages.

The conclusion reached by the writer from the data at hand is that horses became extinct in the glaciated regions of North America, and probably in the larger part or the whole of the continent, about the middle of the Glacial epoch, the Bond County, Ill., specimen being the only one which indicates with some degree of certainty the existence of the genus *Equus* after the Illinoian stage.

Osborn[7] states that our knowledge of the Lower Pleistocene is still confined to the western plains and mountains, while he regards the fauna of the Port Kennedy cave, in Pennsylvania, as illustrating an early phase of the mid-Pleistocene. Now, 80 per cent. of the mammals of this cave belong to extinct species. The Cromer Forest beds, arranged by Osborn in the Pleistocene, by many authors, as Geikie, Lapparent, etc., in the Pliocene, contain, according to Clement Reid, 45 land mammals, of which 21, or about 46 per cent., are extinct. We might, I think, with reason hold that the mammals of the Port Kennedy cave belong to the Pliocene. There seem to be no good grounds for regarding them as more recent than the fauna of the Equus beds of the Great Plains. Calvin's discovery of the mammals of the Aftonian seems to bring the Equus beds up into the lower part of the Glacial epoch, thus abolishing the Preglacial stage. On the other hand, glaciation in North America may have set in earlier than in Europe. Our Equus beds, though interglacial, may nevertheless be also Pliocene.

We may here consider the probable age of the animals collected by Mr. Barnum Brown in the Conard fissure, Newton County, Ark. Mr. Brown has determined 51 species of mammals, of which 24, or about 47 per cent., are extinct, a ratio almost the same as in the case of the land mammals of the Cromer Forest beds. Evidently they belonged to a much later time than those which perished in the Port Kennedy cave. A few of the species seem to indicate a mild climate; most of them, as the wapiti, the musk ox and several burrowing species, show that the climate was rather rigorous. Evidently some one of the glacial ice sheets had pushed down boreal forms into contact with those of a warmer region. The Kansan ice sheet approached within about 200 miles of the fissure. The time of that sheet seems, however, too remote that more than a moiety of the mammals should yet be with us. It is more probable that those remains were assembled in the fissure during the Illinoian stage. The horse was yet in existence. The absence of the large edentates may be due to their extinction at that time or to their expulsion from the region by the low temperature. The bones and teeth of mammoths and mastodons, which certainly were in existence then, were probably too large to be dragged into the fissure.

There is space to consider only a few of the other genera noted by Osborn. The genus *Cervus* is put down as entering the country late in mid-Pleistocene time. However, the wapiti has been reported from a number of localities, among them Big Bone Lick and the

[6] *Bull. Geol. Soc. Amer.*, Vol. 20, pp. 341–356, pls. 16–27.

[7] Bull. 361, p. 84.

Conard fissure. *Rangifer* is stated by Osborn on page 86 as not appearing in the mid-Pleistocene, but on page 87 as coming in late. According to Shaler, *R. tarandus* seems to have been abundant in the older deposits of Big Bone Lick and a species of caribou has been found at Muscatine, Iowa. The late mid-Pleistocene age of the part of the loess containing the *Rangifer* bones is yet to be proved. *Ursus* is a third genus said by Professor Osborn to be a late comer in glacial times. One or two species of the genus were reported from Port Kennedy cave. Two species of the genus, one not distinguishable by Dr. Leidy from the common black bear, were found near Natchez, Miss., in the loess. Shimek, who has made a special study of the loess at Natchez,[8] says that "the solid blue clay," in which the vertebrates of that section have been found, probably does not belong to the loess, but is older still. How old it is no one knows.

According to the table cited above, the two species of mammoth, *Elephas columbi* and *E. primigenius*, disappeared during the mid-Pleistocene, while the mastodon perished during the "upper mid-Pleistocene." Now, northwestern Ohio, northern Indiana and southern Michigan are deeply covered over by a thick mantle of drift materials that was deposited by the Late Wisconsin ice sheet, the very last of the glacial advances. In depressions left on the surface after the retreat of this sheet there were formed lakes and ponds that afterwards became more or less completely filled up, forming marshes, peat bogs and swales. In ditching such places there have frequently been found the teeth and bones, sometimes nearly complete skeletons of the two elephants and of the mastodon. The fine specimen of *E. columbi*, now in the American Museum at New York and described by Professor Osborn, was found in just such a situation. It would be very difficult to prove that the mastodon survived the mammoth. It is certain that both the elephants and the mastodon continued to inhabit the Mississippi Valley long after the glaciers had abandoned the region and therefore during at least a part, if not the whole, of the Postglacial stage of the Pleistocene.

OLIVER P. HAY

[8] *Bull. Lab. Nat. Hist.*, Iowa Univ., V., p. 307.

CATALYTIC ACTION OF IRON SALTS

GIBBS[1] has shown that the red coloration of phenol is due to oxidation brought about by the catalytic action of sunlight. The oxidation products condense and form red substances, as for example, phenoquinone.

As Dr. Fenton has shown that oxygen and sunlight are equivalent to hydrogen peroxide and a trace of a ferrous salt in their oxidizing action upon organic compounds, it struck me that the catalytic action of iron might be studied colorimetrically by resource of Gibb's work.

A concentrated solution of phenol in benzene was divided into three equal parts. The first was exposed to sunlight for two days, the second was treated with a small quantity of hydrogen peroxide, and to the third were added a trace of ferrous sulphate, and then the same quantity of hydrogen peroxide as was added in the second case.

No change could be seen in the first, the second almost immediately developed a very slight pink coloration, but the third at once changed to a reddish-brown color.

Blank experiments were made to show that the color was not due to benzene. Again, in order to prove that the color was not due to the iron alone, traces of a ferrous and a ferric salt were added to a similar benzene solution (without the hydrogen peroxide) when a greenish color was produced, which in no way could be associated with the reddish-brown color caused by iron and peroxide.

Further experiments showed that by means of the above reagents many of the laws of catalysis could be actually demonstrated to a large class in a lecture. More especially because the action was rapid and could be followed by the production of color. For example, to prove in a rough manner that catalysis can not affect the final equilibrium, the two differently colored solutions (one containing traces of iron and the other not)

[1] *Philipp. J. Sci.*, 1909, 4, 133.

are stood aside for a time, when it will be seen that they have both acquired exactly the same color, although the acquisition of it was more rapid in the solution which contained the trace of ferrous sulphate.

Lastly, it has been suggested that the iron merely brings about the catalytic decomposition of the peroxide (if such is the case, as Dr. Fenton has pointed out, why should not other salts produce the same effects?), and this suggestion seems at first sight to be confirmed by the fact that when the solution containing no iron is warmed (thereby bringing about the thermal decomposition of the peroxide, the result of which is just the same as that of "catalytic" decomposition) the color is developed with the same velocity as in the case of the cold solution containing traces of ferrous sulphate.

W. J. S. Naunton

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES

The American Association for the Advancement of Science and the national scientific societies named below will meet at Boston, Mass., during convocation week, beginning on December 27, 1909.

American Association for the Advancement of Science.—Retiring president, Professor T. C. Chamberlin, University of Chicago; president, Dr. David Starr Jordan, of Stanford University; permanent secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.; general secretary, Professor Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio.

Local Executive Committee.—H. W. Tyler, chairman; Thomas Barbour, J. S. Kingsley, Edward R. Warren, John Warren, George W. Swett, secretary.

Section A, Mathematics and Astronomy.—Vice-president, Professor Ernest W. Brown, Yale University; secretary, Professor G. A. Miller, University of Illinois, Urbana, Illinois.

Section B, Physics.—Vice-president, Dr. Louis A. Bauer, Carnegie Institution, Washington, D. C.; secretary, Professor A. D. Cole, Vassar College, Poughkeepsie, N. Y.

Section C, Chemistry.—Vice-president, Professor William McPherson, Ohio State University; secretary, C. H. Herty, University of North Carolina, Chapel Hill, N. C.

Section D, Mechanical Science and Engineering.—Vice-president, Professor John F. Hayford, Northwestern University; secretary, G. W. Bissell, Michigan Agricultural College, East Lansing, Mich.

Section E, Geology and Geography.—Vice-president, Reginald W. Brock, Canadian Geological Survey; secretary, F. P. Gulliver, Norwich, Conn.

Section F, Zoology.—Vice-president, Professor William E. Ritter, La Jolla, Cal.; secretary, Professor Morris A. Bigelow, Columbia University, New York City.

Section G, Botany.—Vice-president, Professor David Penhallow, McGill University; secretary, Professor H. C. Cowles, University of Chicago, Chicago, Ill.

Section H, Anthropology.—Vice-president, Dr. W. H. Holmes, Bureau of American Ethnology; secretary, Dr. George Grant MacCurdy, Yale University, New Haven, Conn.

Section I, Social and Economic Science.—Vice-president, Byron W. Holt, 54 Broad St., New York City; secretary, Dr. John Franklin Crowell, 44 Broad St., New York City.

Section K, Physiology and Experimental Medicine.—Vice-president, Professor C. S. Minot, Harvard Medical School; secretary, Dr. Wm. J. Gies, College of Physicians and Surgeons, Columbia University, New York City.

Section L, Education.—Vice-president, Dean James E. Russell, Columbia University; secretary, Professor C. R. Mann, University of Chicago, Chicago, Ill.

The American Society of Naturalists.—December 29. President, Professor T. H. Morgan, Columbia University; secretary, Dr. H. McE. Knower, University of Toronto, Toronto, Can. *Central Branch.* President, Professor R. A. Harper, University of Wisconsin; secretary, Professor Thomas G. Lee, University of Minnesota, Minneapolis, Minn.

The American Mathematical Society.—December 28–30. President, Professor Maxime Bôcher, Harvard University; secretary, Professor F. N. Cole, 501 West 116th St., New York City.

American Federation of Teachers of the Mathematical and Natural Sciences.—December 27, 28. President, Professor H. W. Tyler, Massachusetts Institute of Technology; secretary, Professor C. R. Mann, University of Chicago, Chicago, Ill.

The American Physical Society.—President, Professor Henry Crew, Northwestern University; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Chemical Society.—December 27–31. President, Dr. Willis R. Whitney, General Electric Company, Schenectady, N. Y.; secretary, Professor Charles L. Parsons, New Hampshire College, Durham, N. H.

The Geological Society of America.—December 29, 31. President, Dr. G. K. Gilbert, U. S. Geological Survey; secretary, Dr. E. O. Hovey, American Museum of Natural History, New York City.

The Association of American Geographers.—December 30–January 1. President, Professor W. M. Davis, Harvard University; secretary, Professor Albert P. Brigham, Colgate University, Hamilton, N. Y.

The American Society of Vertebrate Paleontologists.—December 27–29. President, Dr. J. C. Merriam, University of California; secretary, Dr. E. S. Riggs, Field Museum of Natural History, Chicago, Ill.

The American Society of Biological Chemists.—December 28–30. President, Professor Otto Folin, Harvard Medical School; secretary, Professor William J. Gies, 437 West 59th St., New York City.

The American Physiological Society.—December 28–30. President, Professor W. H. Howell, Johns Hopkins University; secretary, Dr. Reid Hunt, Hygienic Laboratory, 25th and E Sts., N. W., Washington, D. C.

The Association of American Anatomists.—December 28–30. President, Professor J. Playfair McMurrich, University of Toronto; secretary, Professor G. Carl Huber, 1330 Hill St., Ann Arbor, Mich.

The Society of American Bacteriologists.—December 28–30. President, Dr. J. J. Kinyoun, Washington, D. C.; secretary, Dr. Norman MacL. Harris, University of Chicago, Chicago, Ill.

The American Society of Zoologists.—Eastern Branch, December 28–30. President, Professor Herbert S. Jennings, Johns Hopkins University; secretary, Dr. Lorande Loss Woodruff, Yale University, New Haven, Conn.

The Entomological Society of America.—December 29, 30. President, Dr. Henry Skinner, Philadelphia, Pa.; secretary, J. Chester Bradley, Cornell University, Ithaca, N. Y.

The Association of Economic Entomologists.—December 28, 29. President, Professor W. E. Britton, Connecticut Agricultural College; secretary, A. F. Burgess, U. S. Department of Agriculture, Washington, D. C.

The Botanical Society of America.—December 28–31. President, Professor Roland Thaxter, Harvard University; secretary, Professor D. S. Johnson, Johns Hopkins University, Baltimore, Md.

American Nature Study Society.—January 1. President, Professor C. F. Hodge, Clark University; secretary, Professor M. A. Bigelow, Teachers College, Columbia University, New York City.

Sullivant Moss Society.—December 30. President, Professor Bruce Fink, Miami University, Oxford, O.; secretary, Mrs. Annie Morrill Smith, 78 Orange St., Brooklyn, N. Y.

Wild Flower Preservation Society.—President, Professor Chas. E. Bessey; secretary, Dr. Charles Louis Pollard, New Brighton, N. Y.

The American Psychological Association.—December 29–31. President, Professor Charles H. Judd, University of Chicago; secretary, Professor A. H. Pierce, Smith College, Northampton, Mass.

The American Anthropological Association.—December 27–January 1. President, Dr. W. H. Holmes, Bureau of Ethnology; secretary, Dr. Geo. Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-lore Society.—Week of December 30. President, Dr. John R. Swanton, Bureau of American Ethnology; acting secretary, Dr. R. B. Dixon, Peabody Museum, Cambridge, Mass.

Association of Mathematical Teachers in New England.—December 28. President, Charles A. Hobbs, Watertown, Mass.; secretary, George W. Evans, Charlestown High School, Boston, Mass.

Physics Teachers of Washington, D. C.—Meets in conjunction with American Federation of Teachers. President, W. A. Hedrick, McKinley High School, Washington, D. C.; secretary, Dr. Howard L. Hodgkins, George Washington University, Washington, D. C.

American Phytopathological Society.—December 28–30. President, Dr. L. R. Jones, University of Vermont; secretary, Dr. C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

American Alpine Club.—December 30. Secretary, Dr. Henry G. Bryant, Room 806 Land Title Building, Philadelphia, Pa.

American Breeders' Association.—Meeting of Eugenics Committee. Secretary, Dr. Chas. B. Davenport, Cold Spring Harbor, N. Y.

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 670th meeting was held in the West Hall of George Washington University on November 6, 1909, President Wead presiding. Two papers were read.

The Application of the Electrical Resistance Thermometer to Pyrheliometry: Professor C. F. Marvin, of the U. S. Weather Bureau.

Absolute measurements of solar radiation by the use of actinometers, or pyrheliometers, of the Pouillet type, in which the heating and cooling of a short copper cylinder, more or less filled with mercury, alcohol, etc., can not be made with satisfactory accuracy because of the unequal distribution of heat throughout the mass of the block, the differences in specific heat of the component parts, and the uncertainty as to the exact mass of material involved in the observed temperature change.

Most of the difficulties of the problem are minimized or eliminated by the use of the electrical resistance thermometer. For this purpose a short cylinder is formed, about three centimeters in diameter and a half centimeter long, by winding up two layers of very thin ribbon of pure nickel. Layers of very thin silk insulate the coils of nickel from each other, and the whole is cemented by shellac.

The nickel ribbon serves the double purpose of constituting the substance which receives and absorbs the solar radiation to be measured, and, by its large variation of electrical resistance with temperature, it is itself the thermometer that shows its own mean temperature.

The new construction enables the mass and the specific heat of the block to be determined directly.

A pyrheliometer with equatorial mounting and mechanism for operating the shutter by electrical control was exhibited. The auxiliary apparatus for the electrical measurement of temperature was also explained. Plans were described for measuring the amount of radiation which unavoidably falls upon the instrument from a greater or less portion of the sky within 5° or 10° from the sun.

Tentative preliminary observations using a copper block with a nickel-wire thermometer coil imbedded therein gave results from 6 to 10 per cent. lower than the Ångström pyrheliometer. The specific heat of the block was not accurately known.

Seasonal and Storm Vertical Temperature Gradients: Dr. W. J. Humphreys, of the U. S. Weather Bureau.

About one hundred and fifty sounding balloon records, obtained in Europe, were grouped and arranged according to season and to the height of the barometer. On plotting temperature against altitude it was found that during the summer the atmosphere was warmer than in the winter at all levels from the surface of the earth to the greatest altitude reached; or, that seasonal changes in temperature extend to all sounded altitudes. The grouping of the records according to the height of the barometer showed that during the summer a barometric high commonly is accompanied by air which relative to that in a low, is warm from the ground up to about ten kilometers, or to just below the isothermal layer; but that in the isothermal layer it is relatively cold. During the winter the same relations hold at all levels except near (within two kilometers) the surface of the earth where the air is colder when the barometer is high than when it is low.

Presumably these results are not due to mere pressure differences, but rather to the amount of moisture in the atmosphere which is greatest generally when the barometer is low. This moist air, being a good conductor, will cool, under like exposure, to a lower temperature than will an equal amount of dry air, such as is commonly in a high barometer region, and in so doing will radiate more heat to and through the upper air and thereby correspondingly warm it, hence the cool low and warm upper atmosphere when the barometer is low and the air moist, and the reverse when the barometer is high and the air dry.

R. L. Faris,
Secretary

The Scientific Association of Johns Hopkins University

At the meeting of the association in November an interesting lecture was given by Professor B. E. Livingston, the newly elected professor of physiological botany, under the title, "Work of the Desert Laboratory." Professor Livingston presented a brief historical outline of the conception and development of the desert laboratory idea, together with a description of the main botanical features of the country adjacent to Tucson, Ariz., and a consideration of the already excellent material facilities for research at the laboratory. A cursory account of some of the most important problems which have been attacked by the different members of the staff was given, including such topics as the theory of descent and heredity, the physiology of water storage in plants like the cacti, the physiology of parasitism, the special physiological anatomy and morphology of desert species, the physical environmental factors, the ecology of the desert, etc. The lecture was illustrated by lantern slides and photographs.

C. K. Swartz,
Secretary